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SELECTED WATER RESOURCES ABSTRACTS

VOLUME 15, NUMBER 3
MARCH 1, 1982

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A monthly publication of the Office of Water Research and Technology,
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The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through August 31, 1983.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several services of the Office of Water Research and Technology. The cumlative SWRA file from 1968 and monthly updates are available also in magnetic tape through lease from NTIS.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C. 20240

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SELECTED WATER RESOURCES ABSTRACTS

1. NATURE OF WATER

1A. Properties

IDENTIFICATION OF THE WAIRAKEI GEOTHERMAL SYSTEM,
Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Physics and Engineering Lab.
For primary bibliographic entry see Field 2F.
W82-01312

ON IDENTIFICATION AND VALIDATION OF SOME GEOTHERMAL MODELS,
Department of Scienfitic and Industrial Research, Lower Hutt (New Zealand). Physics and Engineering Lab.
For primary bibliographic entry see Field 6A.
W82-01467

1B. Aqueous Solutions and Suspensions

MODELING OF ACTIVATED CARBON AND COAL GASIFICATION CHAR ADSORBENTS IN SINGLE-SOLUTE AND BISOLUTE SYSTEMS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
W. E. Thacker, V. L. Snoeyink, and J. C. Crittenden.
Water Resources Center, University of Illinois, Research Report No 161, July, 1981. 166 p, 31 Fig, 18 Tab, 119 Ref. S-077-ILL.

Descriptors: *Adsorbents, *Mathematical models, Solutes, *Activated carbon, *Coal gasification, *Organic compounds, Hydrologic models, Films, Bed sediment, Mathematical studies, Influent streams, Mathematical equations, Bottom sediments.

This research project had three objectives: (1) to assess the ability of a fixed-bed model to predict the effect of a sustained step change in influent concentration and to describe the process of desorption; (2) to compare with a fixed-bed model the behavior of different adsorbents in the uptake of aqueous organics; and (3) to investigate with a fixed-bed model factors that affect desorption. Both single-solute and bisolute systems were studied. A mathematical model of fixed-bed adsorption was used to predict the bed response to a sustained step change and it was observed that, under conditions approximating a drinking-water plant, the time during which the effluent concentration of a desorbed species was higher than the influent concentration was significant, whether a reduced influent concentration or competition was responsible for the desorption. Model equations, which considered that film transfer and surface diffusion controlled the adsorption rate, were solved with the technique of orthogonal collocation. Three species--3,5-dimethylphenol; 3,4-dichlorophenol; and rhodamine 6G--were the single solutes studied and the two phenols were also examined as a mixture. Four activated carbons and a coal gasification char were the adsorbents studied. The model was used to compare the adsorbents in the removal of DMP, R6G and the bisolute mixtures. Equilibrium capacity was found to have a greater influence than kinetics on fixed-bed performance. Surface area was a better indicator of capacity than pore size distribution for the solutes and adsorbents examined. (Garrison-Omniplan)
W82-01447

2. WATER CYCLE

2A. General

MODELING HYDROLOGIC TIME SERIES FROM THE ARCTIC,
Underwood McLelland and Associates Ltd., Winnipeg (Manitoba).
P. C. Baracos, K. W. Hipel, and A. I. McLeod.
Water Resources Bulletin, Vol 17, No 3, p 414-422, June, 1981. 5 Fig, 8 Tab, 18 Ref.

Descriptors: *Arctic, *Hydrologic data, *Intervention analysis, Cold regions, Meteorological data collection, Stochastic hydrology, *Time series analysis, River flow.

The general intervention model was used with hydrologic and meteorologic data from the Arctic to account for environmental interventions, missing observations in the data, changes in data collection procedures, the effects of external impacts, and extreme seasonality and other autocorrelations. Flow data (10-15 years) from 16 rivers in the Canadian Northwest Territories and meteorological data (30-40 years) from five stations were used to demonstrate the flexibility of the model. Intervention analysis also permitted the extension of 8 years of hydrometric data for the Tree River to an artificially-extended 44-year series, using 44 years of meteorologic data from a nearby weather station at Coppermine. There was good agreement between predicted and observed flows, with largest errors being found in the magnitude of peak flows. (Cassar-FRC)
W82-01198

DRAINAGE NETWORK STRUCTURE AND THE DIAMETER-MAGNITUDE RELATION,
State Univ. of New York at Buffalo. Dept. of Geography.
R. S. Jarvis, and C. H. Sham.
Water Resources Research, Vol 17, No 4, p 1019-1027, August, 1981. 7 Fig, 4 Tab, 18 Ref.

Descriptors: *Drainage patterns, *River basins, *Tributaries, Morphology, Networks, Erosion, Geohydrology, River systems, Basins, Great Britain.

The variation of drainage network structure with basin size was studied in two areas in Britain, the 1400 sq dm Southern Uplands (high plateau, deeply hewn by glacial troughs) and the 1900 sq km Culm Measures region (nonglaciated, open rolling landscape of moderately low relief). The network parameters considered were diameter (maximum number of links in any flow path from a source to the outlet, an index of mainstream length) and magnitude (number of sources in the network, proportional to basin size). Diameter increased with magnitude, but at a decreasing rate as networks were sampled over a greater size range. In the glacial basin the streams tend to follow existing glacial troughs; tributaries are larger and form a more branched Y-shaped network. In a region of normal fluvial erosion, the river network is more elongated and consists of a dominant main stream receiving small tributaries, resembling the ribs of a leaf. The sequence of tributary magnitudes down a main stream is not random. Small tributaries follow other small tributaries along the river course, each requiring little basin space and each having little effect on the size of the next tributary. However, large tributaries spread over wide areas and preclude development of other large tributaries in the near vicinity on their side of the main stream. (Cassar-FRC)
W82-01308

OPTIMAL RISK-BASED DESIGN OF FLOOD LEVEE SYSTEMS,
Nevada Univ. System, Reno. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W82-01313

DRAINAGE DENSITY AS AN INDEX OF CLIMATIC GEOMORPHOLOGY,
Guyana Univ., Georgetown.
J. R. K. Daniel.
Journal of Hydrology, Vol 50, No 1-3, p 147-154, March, 1981. 2 Fig, 13 Ref.

Descriptors: *Drainage density, *Geomorphology, *Denudation, Rainfall-runoff relationships, Runoff, Sediment yield, Guyana, Precipitation, Rainfall, Climatology, Rain forests, Tropical regions, Grasslands, Streamflow.

Most studies on the relationships between climate and denudation in the humid tropics use sediment yield as an important parameter to measure the rate of denudation. Since this data is not available for all catchments, this paper uses drainage density as an alternative morphometric index, combined with mean annual precipitation, to examine a tropical rain forest and a savanna in Guyana. The drainage density was computed from topographic maps, also taking the contour crenulations into consideration. A typical area in the savannas had a drainage density of 2.83 (1.76 km per sq km), and in the tropical forest receiving twice the rainfall, 3.02 (1.88 km per sq km). Drainage density was inversely related to the amount of vegetative cover. Drainage density did not increase proportionately with the rainfall in the tropical forest. The savanna has a high drainage density caused by low rainfall during a short wet season, inhibited plant growth, and greater runoff. In the rain forest the drainage density reaches a maximum level at a mean annual precipitation of about 3000 mm per year, and remains constant or decreases. (Cassar-FRC)
W82-01324

THE WATER BALANCE OF THE BETWA BASIN, INDIA,
Institute of Hydrology, Wallingford (England).
J. V. Sutcliffe, R. P. Agrawal, and J. M. Tucker.
Hydrological Sciences Bulletin, Vol 26, No 2, p 149-158, June, 1981. 4 Fig, 3 Tab, 2 Ref.

Descriptors: *Hydrologic budget, *Soil water, *Groundwater recharge, Rainfall, Runoff, Water storage, Mathematical studies, River basins, *Betwa basin, *India.

An account is provided of the water balance of the Betwa basin, India, as a framework for detailed studies of the hydrological processes and of the hydrogeology. Determination of the water balance was part of an attempt to estimate the seasonal soil moisture storage and groundwater recharge. Data from 1926 through 1975 were used to study rainfall distribution, evaporation was estimated using the Penman method, and long-term annual total inflows to Dhukwan and Matatila dams were estimated. Gross and net rainfall were compared with annual runoff to summarize the water balance. Seasonal soil moisture recharge was estimated at 175 mm. This figure is the average amount of storage available to crops after the monsoon each year. Physical studies are needed to determine more precisely the groundwater recharge for surface and deeper water bodies. (Small-FRC)
W82-01354

OBSERVATIONS ON THE HYDROGRAPHY AND INSHORE PLANKTON OF THE BAY OF BENGAL OFF BALASORE,
Ravenshaw Coll., Cuttack (India). Dept. of Zoology.
S. Pati.
Hydrobiologia, Vol 70, No 1/2, p 123-132, April, 1980. 4 Fig, 34 Ref.

Descriptors: *River runoff *Salinity, *Monsoons, *Bay of Bengal, Zooplankton, Copepods, Path of pollutants, Phytoplankton, Water quality, Runoff, Nutrients, Biomass, Productivity, Invertebrates, *Plankton, Bioindicators, India.

The hydrology of the northern part of the Bay of Bengal near the Balasore coast is governed by the monsoons and the river runoff into the bay. In a study conducted from March 1972 to February 1974, salinity, which varied from 22.35 to 33.62 parts per thousand, was lowest in October, when the two large river systems, the Ganga and the Brahmaputra, discharge huge quantities of freshwater into this part of the bay. The peak values for nutrients (phosphates, 2.26 microgram atom per liter, and nitrates, 13.4 microgram atom per liter) were observed during July to November, coinciding with the southwest monsoons. Surface temperature of the water reached maxima of 19.5

degrees C in May and September, with a minimum of 25 degrees C in winter. Dissolved oxygen concentrations were generally high 3.02-5.30 ml per liter. pH varied from 7.2 to 8.2. Standing crop was highest June to November, with a minor peak in March-April. Plankton biomass, both phytoplankton and copepods, showed peaks in April, July-August, and October. (Cassar-FRC)
W82-01362

A CATCHMENT APPROACH TO FLOOD ESTIMATION,
Northumbrian Water Authority, Gosforth (England).
For primary bibliographic entry see Field 2E.
W82-01397

YEAR-TO-YEAR CHANGES IN THE SALINITY OF THE EASTERN ENGLISH CHANNEL, 1948-1973: A BUDGET,
Institute for Marine Environmental Research, Plymouth (England).
A. H. Taylor, P. C. Reid, T. J. Marsh, T. D. Jonas, and J. A. Stephens.
Journal of the Marine Biological Association of the United Kingdom, Vol 61, No 2, p 489-507, May, 1981. 12 Fig, 2 Tab, 21 Ref.

Descriptors: *Salinity, *Seasonal variation, *River runoff, Runoff, Model studies, *English Channel, Variability, Evaporation, Precipitation, Rainfall, Water circulation, Seawater, Mixing, Water currents, Tides.

River runoff and mixing by wind and tides are the main factors responsible for the seasonal changes of salinity in the eastern English Channel, according to predictions with a model using the calculated monthly mean total runoff data for 1948-73. Total runoff into the eastern English Channel from England and France was assessed at 214 mm or 889 cu m/sec. A long term mean salinity of 35.04 o/oo with a year-to-year variance of 0.0122 o/oo was predicted. This compares well with observed values for the main section of the channel, 35.019 o/oo with a variance of 0.0123 o/oo. Including the monthly evaporation and precipitation changes for 1961-73 improved salinity predictions. The model was able to predict about 80% of the variance of salinity in the eastern English Channel from knowledge of the salinity in the mouth of the Channel by using river runoff, evaporation, and precipitation data. About half the variance in annual mean salinity in the eastern English Channel is the result of abnormally high or low salinity water being transported through the region. Although water movements and salinity variations in the North Atlantic affect salinity of the channel mouth, there is no correlation between salinity fluctuations in the channel entrance and in the eastern English channel. (Cassar-FRC)
W82-01399

TIME DISTRIBUTION OF CLOCK HOUR RAINFALL,
Science and Education Administration, Columbia, MO.
A. T. Hjelmfelt.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980, p 379-385, 8 Fig, 1 Tab, 8 Ref.

Descriptors: *Temporal distribution, *Rainfall, *Simulation, *Runoff, Rainfall-runoff relationships, Small watersheds, Model studies.

Simulation of runoff from rainfall events requires rainfall in time increments not greater than the time to equilibrium for the watershed. For small watersheds the time to equilibrium will be measured in minutes, whereas the easily available rainfall data will be available at clock-four intervals. A rainfall event indicated as occurring in a single clock hour will have an actual duration of not more than 60 minutes. The 60 minute equivalent is considered to be 1.13 times the clock hour rainfall. When determining time distribution of rainfall from clock hour quantities, the great variability in events must be recognized. At this time there seems little advantage in applying an average distribution to any storm with values recorded in 3 clock-hours or more. The average intensity for each hour is probably the best estimate. Most storms occurring in 1 clock-hour will last less than 60 minutes. Using the total hour as the duration will underestimate the peak discharge. Multiplying the clock hour value by 1.13 should result in the equivalent, on a return period basis, 60 minute catch on the average. The equivalent 60 minute catch can be used to obtain the time distribution for peak discharge estimates. (See also W82-10401) (Moore-SRC)
W82-01402

THE SIGNIFICANCE OF SNOWMELT ON WATER SUPPLIES IN THE NORTHEAST,
Jordan (Edward C.) Co., Inc., Portland, ME. Water Service Dept.
S. Medlar.
Journal of the New England Water Works Association, Vol 95, No 2, p 134-144, June, 1981. 4 Tab, 13 Ref.

Descriptors: *Snowmelt, *Snow depth, *Runoff, Groundwater recharge, Thaw, Rainfall, Snow density, Snow accumulation, Snow, Water supply, Northeastern United States, *New England.

Snowfall in New England for the winter of 1979-80 was analyzed to investigate the role of snowmelt in the availability of water supplies. Field information about depth and water content can be used to estimate potential runoff from snow. The average water content of snow in New England is about 18-19%, and the volume of snowmelt that reaches a reservoir depends on surface topography, frozen or thawed soil, air dynamics, watershed conditions, sunlight, temperature, wind, and vegetation. Snowmelt influences water quality by suspending turbidity, dissolving color, diluting chlorides, and changing pH. Evaporation from snow can be 80%, and snow on the ground will absorb rain until saturated. Snowmelt contributes to major flooding, and groundwater recharge is affected by snowmelt water infiltration. Rainfall has a greater recovery value than snow. The extent of this difference in recovery depends upon the time delay between precipitation and melting. (Small-FRC)
W82-01488

USING COMPUTED STREAM FLOW IN WATERSHED ANALYSIS,
Delaware Univ., Newark. Dept. of Geography.
J. R. Mather.
Water Resources Bulletin, Vol 17, No 3, p 474-482, June, 1981. 8 Fig, 3 Tab, 10 Ref.

Descriptors: *Hydrologic budget, *Streamflow, *Watersheds, Climatology, Rainfall-runoff relationships, River basins, Precipitation, *Delmarva Peninsula, Regression analysis, Runoff, Stream gages.

Observed and computed streamflows were compared on a monthly and annual basis for 28 basins on the Delmarva peninsula, a region with little snow cover. The results of correlation-regression analysis produced three groupings of basins. For the 8 basins in the first category, the calculations obtained from the climatic water budget were in good agreement with observed streams runoff figures (regression line slope = 1). In the second group of 10 basins a regression line slope = 1 was obtained, but it was displaced from the y = x line. A slight correction of the water budget (moisture storage in the root zone of the soil) produced good agreement between calculated and observed streamflow values. The third category, including 10 watersheds, had serious differences between values, which pointed to hydrologic peculiarities in the basins (deep aquifer leakage, interbasin transfers, gage error, and difference in root zone water storage). The Manokin Branch, which had the greatest differences (r = 0.61, y = 0.38 x plus 3.76) revealed a sharp change in correlation in 1968. A search of records uncovered that in that year ditching operations were started and sheet metal panels were installed around the gage. (Cassar-FRC)
W82-01538

018 MODELLING OF FRESHWATER INPUTS IN BAFFIN BAY AND CANADIAN ARCTIC COASTAL WATERS,
Quebec Univ., Montreal. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2C.
W82-01590

2B. Precipitation

FATTY ACID AND HYDROCARBON CONTENT OF SETTLING SEDIMENTS IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
For primary bibliographic entry see Field 2H.
W82-01154

A DENDROCLIMATIC RECONSTRUCTION OF ANNUAL PRECIPITATION AMOUNTS IN IOWA SINCE 1680,
Oak Ridge National Lab., TN.
D. N. Duvick, and T. J. Blasing.
Water Resources Research, Vol 17, No 4, p 1183-1189, August, 1981. 4 Fig, 2 Tab, 13 Ref.

Descriptors: *Drought, *Climatic data, *Dendrochronology, *Precipitation, *Iowa, Trees, Tree rings, Regression analysis.

Core samples from 30 white oak trees at each of three sites in central Iowa were used to determine the tree ring widths and, in turn, the total precipitation for the period about one year preceding the end of radial growth. Regression analysis of this data produced annual (August-July) precipitation information for the years 1680-1979. Predicted precipitation agreed well with precipitation in years for which data were available. Reconstructed data indicate five 10-year periods comparable in dryness to the 1930's: 1816-1825, 1735-1744, 1696-1705, 1931-1940, and 1791-1800, listed in order of decreasing dryness. The 12-year 1816-1827 period was an uninterrupted drought with yearly precipitation ranging from 62.8 cm to 79.1 cm. These values suggest that long-term planners should consider the possibility of about two such droughts each century. Such a dry spell could seriously affect water supplies in Iowa. (Cassar-FRC)
W82-01314

DEUTERIUM/HYDROGEN RATIOS IN AUSTRALIAN RAINFALL,
Australian Atomic Energy Commission Research Establishment, Lucas Heights.
P. E. Hartley.
Journal of Hydrology, Vol 50, No 1-3, p 217-229, March, 1981. 1 Fig, 1 Tab, 20 Ref.

Descriptors: *Deuterium, *Rainfall intensity, *Isotope studies, Dew point, Climatology, *Australia, Groundwater, Precipitation, Model studies.

A simple model was developed to clarify the way in which the isotopic composition of precipitation (deuterium/hydrogen ratios) is influenced by meteorological variables. The model is consistent with monthly data measured over 3 years at 14 Australian sites. The major influences on D/H ratios are dew point and rainfall intensity. Intense storms reduce the fractionation, producing isotopically lighter rain. The lower the average rainfall of a station, the lower its D/H ratio; but the higher the rainfall in any month at a given station, the lower the D/H ratio for that month. A low dew point is associated with isotopically light vapor and less intense rain, which is isotopically heavier for a given vapor composition, resulting in a negative correlation between D content and dew point at lower latitudes (12 to 30 degrees S) and a positive correlation at higher latitudes (32 to 38 degrees S). These findings show that false conclusions may be reached in attempts to relate climate to D/H ratios of ancient groundwaters by assuming that the isotopic composition of the precipitation causing re-

charge is always directly related to average annual temperature at the time of recharge. (Cassar-FRC)
W82-01325

NOTE ON PROBABILITY APPROACH TO STUDY THE OCCURRENCE OF RAINFALL AT HYDERABAD,
All-India Co-ordinated Rice Improvement Project, Hyderabad (India).
R. K. Mahajan, and A. V. Rao.
Indian Journal of Agricultural Sciences, Vol 51, No 1, p 62-65, January, 1981. 1 Fig, 1 Tab, 4 Ref.

Descriptors: *Rainfall, *Probability distribution, Probabilistic process, Mathematical studies, Stochastic process, Frequency distribution, Rainfall distribution, Farm management, Crop yield, Hyderabad, *India.

An attempt was made to study the behavior of occurrence of dry and wet days during the crop season of rice and to determine the optimum sowing time by computing the weekly rainfall probabilities. Data relating to rainfall from 1 June to 30 September was collected for studying the distribution of rainfall. The difference between the probabilities of wet day preceded by a dry day, P (W/D), and wet day preceded by a wet day, p (W/W) tested year-wise by the usual normal deviate statistic revealed that the occurrence of a wet (or dry) day was highly influenced by the previous day's weather in all the years studied. Thus the occurrence of wet and dry days in the given tract could be strictly described by a 2-state Markov chain with the transition probability as demonstrated. The occurrence of a dry day was more probable than the occurrence of a wet day. The expected cycle of wet and dry days was 7 days. The expected number of wet and dry days was 35 and 87 days, respectively. Such data are helpful in planning proper management of crops for highest potential yield. (Baker-FRC)
W82-01380

ANOMALOUS SNOWFALL CAUSED BY NATURAL-DRAFT COOLING TOWERS,
Rand Corp., Santa Monica, CA.
L. R. Koenig.
Atmospheric Environment, Vol 15, No 7, p 1117-1128, 1981. 11 Fig, 3 Tab, 19 Ref.

Descriptors: *Cooling towers, *Snow, Precipitation, Temperature effects, Plumes, Clouds, Water vapor.

The potential for snowfall from cooling-tower plumes was investigated. Occurrences of this type have been documented in the literature. Direct observations indicate that the areal extent of snowfall from cooling towers greatly exceeds the resolution of several satellite systems, and therefore should be detected in their imagery. The model used in the present study predicts the characteristics of a plume element, or puff, as it emerges from the cooling tower, rises, and travels downwind. In all cases reported, the moisture source flux is 1000 kg/sec. It is emitted to the atmosphere as saturated air having a temperature of 25 degrees C. These conditions are appropriate for wet towers at a plant delivering about 2500 MW of electricity. In the runs discussed in this problem, the plume depth was limited to 500 meters. It was concluded that the amount of snow falling from cooling towers plumes depends on the outcome of the competition between the evaporation of the plume and the total growth of ice particles. The depth of snow depends on these factors plus the dispersion of the snow. The growth of ice depends on the concentration of ice particles and their growth rates. The evaporation of the plume depends on the ability of the ambient air to receive water vapor and the rate of mixing between the plume and its surroundings. Criteria were figured to include temperatures below minus 13 degrees C and ambient water vapor deficits less than 0.5 g/cubic meter in order for measurable snow to fall within about 50 km of a 100 kg/sec water vapor source, assuming that wind speeds are about 10 m/sec at the plume. (Baker-FRC)
W82-01512

AN ANALYSIS OF ACIDIC PRECIPITATION IN SOUTH-CENTRAL ONTARIO USING AIR PARCEL TRAJECTORIES,
Ontario Ministry of the Environment, Toronto.
For primary bibliographic entry see Field 5B.
W82-01513

RECENT ACIDIFICATION OF PRECIPITATION IN NORTH AMERICA,
Cornell University, Ithaca, NY. Section of Ecology and Systematics.
For primary bibliographic entry see Field 5B.
W82-01514

THE INFERENCE OF GATE CONVECTIVE RAINFALL FROM SMS-1 IMAGERY,
National Hurricane and Experimental Meteorology Lab., Coral Gables, FL.
For primary bibliographic entry see Field 7B.
W82-01519

ICE NUCLEUS CONCENTRATIONS MEASURED DURING THE 1975 FLORIDA AREA CUMULUS EXPERIMENT (FACE),
MITRE Corp., McLean, VA.
For primary bibliographic entry see Field 7B.
W82-01522

AN IMPROVED METHOD FOR OBTAINING THE WATER CONTENT VALUES OF ICE HYDROMETEORS FROM AIRCRAFT AND RADAR DATA,
Air Force Geophysics Lab., Hanscom AFB, MA.
For primary bibliographic entry see Field 7B.
W82-01523

SIMULATION OF DAILY WEATHER DATA USING THEORETICAL PROBABILITY DISTRIBUTIONS,
Cornell Univ., Ithaca, NY. Dept. of Plant Pathology.
J. A. Bruhn, W. E. Fry, and G. W. Fick.
Journal of Applied Meteorology, Vol 19, No 9, p 1029-1036, September, 1980. 7 Tab, 25 Ref.

Descriptors: *Stochastic hydrology, *Weather data simulation, Distribution, Model studies, Computer models, Simulation, Agriculture, Meteorological data simulation, Precipitation, *Probability distribution, Temperature, Relative humidity, Solar radiation.

A computer model was developed to simulate daily weather data (precipitation, maximum and minimum temperature, minimum relative humidity, and total solar radiation) for agricultural purposes using a Monte Carlo technique. Two processes common to the generation of values for each weather variable were: (1) selection of a set of parameters to describe the appropriate probability distribution, using rainfall as a foundation and (2) generation of a random value from the selected probability distribution (the current day's value of the weather variable). Precipitation occurrence was described by a first order Markov chain; the amount of rain, by a probability distribution; minimum and maximum temperatures, by a trivariate normal probability distribution considering temperature on the previous and current days; and minimum relative humidity and total solar radiation, by normal distribution. The model was tested on actual weather data from Geneva, New York, and Fort Collins, Colorado, and good agreement was obtained between simulated and historical data regarding mean response, variability, and pattern of correlation associated with daily weather data from each location. Particularly accurate were precipitation, minimum temperature, and maximum temperature. (Cassar-FRC)
W82-01526

WEATHER MODIFICATION FROM COOLING TOWERS. A TEST BASED ON THE DISTRIBUTIONAL PROPERTIES OF RAINFALL,
Oak Ridge National Lab., TN. Engineering Technology Div.
A. A. N. Patrinos, and K. O. Bowman.
Journal of Applied Meteorology, Vol 19, No 3, p 290-297, March, 1980. 4 Fig, 4 Tab, 20 Ref.

Descriptors: *Weather modification, *Cooling towers, Model studies, Rainfall distribution, Artificial precipitation, Rainfall, Artificial storms, *Statistical analysis, Mathematical models.

A statistical technique is presented for the treatment of data from weather modification experiments. Data has been collected by 49 recording raingages and four recording windsets situated on a square grid installed in early 1978 to determine the potential precipitation modification effects of the Bowen Electric Generating Plant near Cartersville, Georgia. The statistical technique presented makes use of a design which resembles the crossover statistical design used in cloud seeding studies and employs the distributional properties of the sample skewness and kurtosis. The technique demonstrated an anomaly in the target area rainfall with a 90% confidence level. This anomaly is interpreted as a plant induced modification of the spatial variability of rainfall volume. No attempt was made to stratify the precipitation events by storm type or by power plant output. (Baker-FRC)
W82-01527

AN INDEX OF ARIZONA SUMMER RAINFALL DEVELOPED THROUGH EIGENVECTOR ANALYSIS,
Portland State Univ., OR.
D. M. Johnson.
Journal of Applied Meteorology, Vol 19, No 7, p 849-856, July, 1980. 7 Fig, 1 Tab, 14 Ref.

Descriptors: *Rainfall, *Mathematical studies, Variability, Spatial distribution, *Arizona, Mapping, Seasonal variation, *Summer rainfall.

Eigenvector analysis has been used to establish a single index to characterize the statewide pattern of Arizona summer rainfall. Summer storms are in most cases a response to subtropical atmospheric controls in this area. Summer rainfall contributes more to annual precipitation than does the total precipitation occurring during winter. All available climatological stations in Arizona and adjacent areas supplied data concerning the length and quality of summer precipitation records. The eigenvectors or a variance-covariance matrix are analogous to the principal components of a data set. The data matrix for this study consisted of the summer rainfall totals at 101 stations over a 50 year period. The eigenvectors become a new set of axes which represent the original data. The first time-series eigenvector was extracted and accounted for 70% of the variance. Geographic mapping of the multipliers revealed that the first eigenvector did adhere to physical reality, in that it reflected the dominant pattern of rainfall over the state. Thus its validity as an effective index was established. (Baker-FRC)
W82-01528

LIDAR DETERMINATIONS OF ATMOSPHERIC ICE CRYSTAL LAYERS AT SOUTH POLE DURING CLEAR-SKY PRECIPITATION,
Nevada Univ. System, Reno. Desert Research Inst.
For primary bibliographic entry see Field 2C.
W82-01529

A COMPARISON OF TWO SATELLITE RAINFALL ESTIMATES FOR GATE,
Hawaii Univ., Honolulu. Joint Inst. for Marine and Atmospheric Research.
For primary bibliographic entry see Field 7B.
W82-01533

DETERMINATION OF MOISTURE FROM NOAA POLAR ORBITING SATELLITE SOUNDING RADIANCES,
National Earth Satellite Service, Washington, DC.
C. M. Hayden, W. L. Smith, and H. M. Woolf.
Journal of Applied Meteorology, Vol 20, No 4, p 450-466, April, 1981. 8 Fig, 8 Tab, 11 Ref.

Descriptors: *Remote sensing, *Atmospheric water, *Moisture content, Meteorological data collection, *Satellite technology, Radiosondes, Clouds, Weather forecasting.

A newly-developed method improves the determination of atmospheric moisture from satellite measurements. The three major changes to current operational methods are: (1) the surface contribution to the out-going radiance is substracted before making temperature and moisture retrievals, allowing better definition of low-level moisture gradients. (2) The temperature/moisture solution is subjected to a one-channel iteration to ensure that the radiative transfer equation is satisfied for low-level moisture, valuable in cases of extreme dryness. (3) A cloud moisture model defines the atmospheric moisture below the cloud in areas of extensive cloud cover, permitting a more geographically uniform picture of the moisture. TIROS-N observations made on April 10, 1979, nearly coinciding with a tornado outbreak at Wichita Falls, Texas, were used in the simulation and found credible in estimating moisture in broad layers, surface to 700 mb and 850 to 500 mb. High moisture gradients are clearly defined, and horizontal consistency is achieved. Although point comparisons with radiosondes show large discrepancies, these are explained by the difference in sampling methods. (Cassar-FRC)
W82-01535

2C. Snow, Ice, and Frost

WAVE FORMATION AND HEAT TRANSFER AT AN ICE-WATER INTERFACE IN THE PRESENCE OF A TURBULENT FLOW,
Alberta Univ., Edmonton. Dept. of Mechanical Engineering.
R. R. Gilpin, T. Hirata, and K. C. Cheng.
Journal of Fluid Mechanics, Vol 99, No 3, p 619-640, August, 1980. 13 Fig, 42 Ref.

Descriptors: *Ice-water interfaces, *Wave propagation, *Heat transfer, *Turbulent flow, Waves, Flow, Accumulation, Melting, Temperature effects.

The stability and subsequent wave growth of disturbances to an ice-water interface in the presence of a turbulent boundary-layer flow were studied experimentally. Observation of instability in the presence of a well-defined flow regime made possible the comparison of the character and stability criterion for the waves. Stability was controlled by the heat flux from the interface into the ice. Generally, when the heat flux is small as during melting, the interface is most likely to be unstable. During ice accumulation, the heat flux is large and the interface is stable. Conditions necessary for unstable ice during ice accumulation were determined. These included a sufficiently large temperature ratio and a growing ice layer with a ratio of ice-side to water-side heat fluxes of up to 2.3. These results apply only where a turbulent boundary layer is present. The same controlling factors may also be important in other flows, however. (Small-FRC)
W82-01128

EFFECT OF GRAIN SIZE AND SNOWPACK WATER EQUIVALENCE ON VISIBLE AND NEAR-INFRARED SATELLITE OBSERVATIONS OF SNOW,
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 7B.
W82-01311

WATER FROST AND ICE: THE NEAR-INFRARED SPECTRAL REFLECTANCE 0.65-2.5 MICRONS,
Hawaii Univ., Honolulu. Inst. for Astronomy.
R. N. Clark.
Journal of Geophysical Research, Vol 86, No B4, p 3087-3096, April, 1981. 11 Fig, 3 Tab, 19 Ref.

Descriptors: *Reflectance, *Ice, *Frost, Spectral analysis, *Remote sensing, Optical properties, Algorithms, Mathematical studies.

Reflectance spectra of water frost and water frost on ice are presented to demonstrate the large range of spectral contrasts and features which may be encountered in remote sensing of planetary surfaces. The data are presented with 1.5% spectral resolution in the 0.65 to 2.5 micron wavelength region. The following water absorption bands (in microns) are precisely defined: 2.0, 1.65, 1.5, the little-studied 1.25, and three previously unidentified bands (1.04, 0.90, and 0.81). A quantitative analysis was performed of the 1.5 band complex using a nonlinear least squares algorithm to resolve the band into four Gaussian components as a function of grain size and temperature. The 1.65 component was highly grain-size dependent and not a good temperature sensor as was previously thought. Also, width was found to depend on grain size but was independent of temperature. The apparent band depths seen in many planetary reflectance spectra may be explained by the fact that the relative apparent band depths are different for frost layers on ice than for thick layers of frost. (Small-FRC)
W82-01346

COMPATIBILITY OF CANADIAN SNOWFALL AND SNOW COVER DATA,
Atmospheric Environment Service, Downsview (Ontario).
B. E. Goodison.
Water Resources Research, Vol 17, No 4, p 893-900, August, 1981. 7 Fig, 3 Tab, 17 Ref.

Descriptors: *Snow cover, *Snow surveys, *Gaging, Snow depth, Snow accumulation, Snow density, Snow sampling, Snow courses, Model studies, Data collections, Precipitation, Network design, Sampling, Cold Creek basin, *Ontario, Water equivalent, *Moisture equivalent.

The accuracy and compatibility of different methods of measuring snowfall were studied in the Cold Creek Basin, Ontario. Snow was measured for snowstorms in the winter of 1972-73 using a ruler estimate based on the 10:1 ratio and the following gages: Nipher, unshielded Universal, unshielded and Alter-shielded Fischer and Porter, and Universal with Alter shield. Good agreement in storm or seasonal totals was obtained for the gaged installations after correction for environmental factors such as wind speed. The ruler estimation was inconsistent and unreliable for use in short-term analyses. The significant differences in snow cover between land use categories were maximum at the time of peak accumulation, reflecting the ability of different types of vegetation to accumulate and retain snow in an individual way. Open areas had the highest density, lowest snow water equivalent, lowest depth, and most variable snow cover. An increase in sampling density in these areas would improve reliability of results. A simple mass balance model, using corrected precipitation data, can also determine snowpack accumulation. Net snow cover determined in this manner less the melt losses and snow evaporation were within confidence limits of the mean snow cover measured in the basin. Hydrologic models can use data from various methods and locations provided: (1) precipitation measurements are corrected for gage catch variations, and (2) snow survey data represents the basin land use. (Cassar-FRC)
W82-01466

THE BEHAVIOR OF A POLAR ICE-DAMMED LAKE, ELLESMERE ISLAND, N.W.T., CANADA,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
S. P. Blachut, and S. B. McCann.
Arctic and Alpine Research, Vol 13, No 1, p 63-74, February, 1981. 5 Fig, 1 Tab, 32 Ref.

Descriptors: *Iced lakes, *Polar regions, *Hydrologic budget, Ice dams, Flow discharge, Polar ice, *Canada, *Eilesmere Island, Watersheds, River flow, Flooding.

Most of the literature on ice-dammed lakes deals with lakes associated with temperate glaciers. However, recent observations indicate that there may be many lakes associated with cold or polar ice. Preliminary reconnaissance suggested that a small, deep, isothermal lake ponded against the western margin of the Ellesmere Ice Cap on Ellesmere Island in Canada might be an important source of sudden inputs of water into the main river system of the area. Sudden, partial drainage of this lake was observed in three successive years, 1973 through 1975. Glacier outburst floods (jokulhlaups) occurred in each of these years, with the 1973 event being the most severe. The water balance of the lake and the characteristics of the ice dam, monitored in 1974, indicated that barrier flotation was the key factor in the initiation of the jokulhlaups. There did not appear to be any leakage through the ice dam prior to the jokulhlaups, which began with a violent and forceful extrusion of water at high pressure at the outlet. The annual drainage events were separate events, with drainage initiated at progressively lower levels each year. Both the total volume of water discharged and the maximum rates of discharge were smaller with each successive year. The discharge rate decreased rapidly after the first few days of the drainage event. Barrier lifting and disturbance due to flotation of the shelf ice, resulting from rising lake levels during the first part of the summer season, appeared to be the trigger mechanism initiating lake drainage. The decreasing magnitude of the jokulhlaups and the fall in maximum lake levels over the 3 year period suggest that a series of annual drainage events might be succeeded by a period of nondrainage or lake recharge. (Carroll-FRC)
W82-01511

LIDAR DETERMINATIONS OF ATMOSPHERIC ICE CRYSTAL LAYERS AT SOUTH POLE DURING CLEAR-SKY PRECIPITATION,
Nevada Univ. System, Reno. Desert Research Inst.
V. N. Smiley, B. M. Whitcomb, B. M. Morley, and J. A. Warburton.
Journal of Applied Meteorology, Vol 19, No 9, p 1074-1090, September, 1980. 18 Fig, 3 Tab, 24 Ref.

Descriptors: *Ice, *Crystal growth, Crystals, Measuring instruments, Precipitation, Antarctic, *South Pole, Clouds, Cloud seeding, Temperature, Wind, *Water content, *Atmospheric ice.

An attempt was made to determine at what altitudes ice crystals form and grow during clear-sky precipitation events at the South Pole. The study was conducted between March and November of 1975. The usefulness of the lidar technique for studying atmospheric ice crystal layers was amply demonstrated by this study. Four distinct lidar signatures were observed for 36 clear-sky precipitation events. The air masses in which the clear-sky precipitation events were occurring were rising from lower terrain. The average height of the precipitation layer tops for the 36 events was 500 (plus or minus 160) meters, which was somewhat below the average inversion height of 560 (plus or minus 190) meters. In most all cases the formation layer tops were above the inversion level. The relationships between heights of precipitation layer tops and inversions and their respective temperatures demonstrate that the influence of layers above the precipitation layer is apparently quite important, as they were present in 75% of the 36 events. The larger crystals observed were plates and clusters. The maximum temperatures at the inversion for the six events for which replicator data were reduced were between -34.6 and 41.1 degrees C, and the larger crystals usually started growing at somewhat colder temperatures at heights varying from 300 to about 2000 meters. For the six days for which replicator data were reduced, the air was supersaturated with respect to ice over a range of several hundred meters above and below the inversion in at least four instances. (Baker-FRC)
W82-01529

ICE BLOCKS MELTING INTO A SALINITY GRADIENT,
Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
H. E. Huppert, and J. S. Turner.
Journal of Fluid Mechanics, Vol 100, No 2, p 367-384, September, 1980. 11 Fig, 5 Tab, 15 Ref.

Descriptors: *Ice-water interfaces, *Melting, *Saline-freshwater interfaces, Icebergs, Melt

water. Ice-brine systems, Fluid mechanics, Arctic, Antarctic.

Water originating from ice melting in fluid stratified with salt undergoes little vertical displacement. The melt water flows out of a thin vertical boundary layer near the ice into a series of horizontal layers. This principle could be used in collecting fresh melt water from icebergs as a water supply source. The melting process takes place mainly on the vertical walls. Being lighter, the melt water rises up the sides of the iceberg in a thin layer. This inner layer of water mixes with that in a thicker, outer boundary layer which is moving downwards. When the downward moving water reaches the level where its density equals that of the far-field water, it starts to move horizontaly and produces layers, separated from each other by a thin interface. For Antarctic conditions the typical layer thickness may be 10-30 meters and for Arctic conditions, only a few meters. The melting process was studied in the laboratory in tanks using water of uniform salinity and linearly stratified with salt and either aluminum containers or ice blocks. Motions of the water were made visible with a shadowgraph technique or flourescein and were photographed for study. (Cassar-FRC)
W82-01530

MONITORING GLACIER OUTBURST FLOODS,
National Hydrology Research Inst., Ottawa (Ontario). Div. of Snow and Ice.
G. J. Young.
Nordic Hydrology, Vol 11, No 5, p 285-300, 1980. 6 Fig, 42 Ref.

Descriptors: *Glacial lakes, *Floods, *Monitoring, Lakes, *Glaciohydrology, Ice, Dams, Reviews, Disasters, Jokulhlaups, Forecasting, *Flood forecasting, Streamflow, Snowmelt, Glacial streams, Alpine regions.

The literature on jokulhlaups (an Icelandic term describing glacial outburst floods) is reviewed. This phenomenon occurs when water impounded by ice dams, or within or on top of glacial ice, is released. Jokulhlaups, found today in most glacier-covered areas, were probably more extensive and catastrophic during the height of the last glacial period. The most common type of lake is found in an ice-free tributary valley at the side of a major valley glacier. Other less common formations produce lakes between two converging glaciers, in major ice-free valleys, and within, under, and on the surface of glaciers. Very few outbursts have been observed and documented thoroughly because they may last only a few days once every several years and produce huge, hard-to-measure discharges. The dammed water may drain under, over, or through the ice. If an outburst coincides with a snowmlet flood or major rainfall, the event may be catastrophic. Since monitoring is very difficult, forecasters must rely on case histories. Present day lakes may be identified from air photographs or satellite imagery. Past lakes are located from geomorphological and vegetational records. Summit Lake, British Columbia, dammed by the Salmon Glacier and typical of the most common situation, is described in detail. It is 5.25 km long, 0.45 to 1.25 km wide and 200 meters deep at the ice front. Apparently no emptying occurred between 1900 and 1961. The five floods between 1961 and 1970 occurred between August and December. The lake did not always fill completely before discharging. When the lake surface reaches 800 meters above sea level, careful monitoring detects the beginning of the outflow, which reaches a peak in 3-5 days, allowing a mining company downstream to prepare for road washouts. (Cassar-FRC)
W82-01558

SNOWMELT PREDICTION IN A SUBARCTIC DRAINAGE AREA,
Saskatchewan Univ., Saskatoon. Dept. of Geography.
J. E. Fitzgibbon, and T. Dunne.
Nordic Hydrology, Vol 11, No 5, p 243-254, 1980. 3 Fig, 3 Tab, 8 Ref.

Descriptors: *Snowmelt, *Runoff, *Model studies, Subarctic zone, Vegetation effects.

Three methods for predicting snowmelt were tested in a variety of subarctic environments classified according to vegetation cover (closed lichen woodland, open lichen woodland, regenerating burn, and burn) near Schefferville, Quebec. The crown covers for each of these categories were 25-25%, 15-25%, 5-15%, and 0-5%, respectively. The temperature index method (using mean daily air temperature) and the U.S. Army Corps of Engineers empirical energy balance method gave adequate predictions in all four melt environments. Errors expressed in % of observed snowmelt were 14-26% and 14-24%, respectively, for each method. The physical energy balance method was good for the burn areas (9% error) and not as good for the other three environments (18-40% error). (Cassar-FRC)
W82-01571

EVALUATION OF ULTRAVIOLET SPECTROPHOTOMETRIC DETERMINATION OF NITRATE-NITROGEN IN GLACIAL SNOW, FIRN AND ICE,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
For primary bibliographic entry see Field 5A.
W82-01572

018 MODELLING OF FRESHWATER INPUTS IN BAFFIN BAY AND CANADIAN ARCTIC COASTAL WATERS,
Quebec Univ., Montreal. Dept. of Earth Sciences.
P. Bedard, C. Hillare-Marcel, and P. Page.
Nature, Vol 293, No 5830, p 287-289, September 24, 1981. 4 Fig, 16 Ref.

Descriptors: *Oxygen isotopes, *Isotopic studies, Arctic, Coastal waters, Canada, *Baffin Bay, *Sea ice, Melting, Model studies, Salinity, *Saline-freshwater interfaces, Glaciers, Icebergs, Fjords, Seawater, Greenland.

Measurements of 018 versus salinity in surficial samples of Arctic coastal waters from the north shore of Alaska to western Greenland disclosed three types of water: marine standard water, continental fresh water, and sea ice melt water. A three-component model (Tan and Strain, 1980), design for Baffin Bay waters, is applied here to a larger geographical scale. The Qaumarujuk Fjord, Greenland, is an example of a two-component model--glacial meltwater mixing with marine water, no sea ice component. The Cornelius Grinnell Fjord, Baffin Island, shows glacier water and standard marine water mixing and, towards the open sea, the influence of sea ice is noted. In the Beaufort Sea along the Yukon and Alaska coast, isotopic compositions reflect the composition of the water from the Mackenzie River drainage basin. A few samples show the presence of sea ice melt water. The Arctic archipelago and northern Baffin Bay waters reflect a heterogeneous and discrete continental input and a strong influence of sea ice melt water. Marine waters have salinities of about 34.9 o/oo and delta 018 values of 0 to -0.7 o/oo; continental waters, zero salinity and delta 018 of -17 o/oo to -21 o/oo; and sea ice melt water, salinity of 2 to 9.3 o/oo and variable delta 018. (Cassar-FRC)
W82-01590

2D. Evaporation and Transpiration

ESTIMATING EVAPOTRANSPIRATION FROM IRRIGATED CROPS IN SOUTHWESTERN ONTARIO,
Department of Agriculture, Harrow (Ontario). Research Station.
C. S. Tan, and J. M. Fulton.
Canadian Journal of Plant Science, Vol 61, No 2, p 425-435, April, 1981. 10 Fig, 27 Ref.

Descriptors: *Evapotranspiration, *Crop yield, Irrigation, Farming, Plant-soil-water relationships, Water conservation, Model studies, Climatology, *Ontario.

Meteorological data and measured evaporanspiration (ET) data from irrigated crops on Fox sandy loam were used to develop an equilibrium evapotranspiration (ETeq) model. The model inputs were daily maximum and minimum air temperatures and sunshine duration measurements, which are available from local weather stations. A simple equation was developed from the equilibrium model to estimate ET, and was tested on irrigated crops over a fairly wide range of moisture and foliage cover conditions. Reasonably good agreement was achieved between ET measured with floating lysimeters and ETeq estimated with the model. The total yields of irrigated early potatoes, corn and processing tomatoes were directly related to accumulated ET rates during the growing season in southwestern Ontario. When root zone water storage and available soil moisture were high (the latter above 60% for potatoes, 50% for tomatoes and 25% for corn) the ratio of evapotranspiration to equilibrium evapotranspiration remained fairly constant. However, below these limits the ratio declines rapidly with decreasing available soil moisture. (Baker-FRC)
W82-01116

ESTIMATING EVAPOTRANSPIRATION FROM THE SONOITA CREEK WATERSHED NEAR PATAGONIA, ARIZONA,
Ben Gurion Univ. of the Negev, Beersheba (Israel). Inst. for Desert Research.
J. Ben-Asher.
Water Resources Research, Vol 17, No 4, p 901-906, August, 1981. 4 Fig, 2 Tab, 12 Ref. OWRT-A-069-ARIZ(5).

Descriptors: *Evapotranspiration, *Small watersheds, Watersheds, *Sonoita Creek, *Arizona, Model studies, Soil-plant-water relationships.

As part of a general study on surface and groundwater regimes in the 620 sq km Sonoita Creek watershed, Arizona, a model of monthly evapotranspiration (Morton's conceptual approach for large areas) was tested. A unique aspect of this watershed is the strip of dense riparian vegetation where the actual evapotranspiration equals the potential evapotranspiration. For the rest of the watershed, actual evapotranspiration is less than the potential because it is dependent on rainfall. Climatological data included were solar radiation, dew point temperature, mean monthly temperature, and humidity. The model was validated by comparing predicted and actual evapotranspiration in Africa at a similar latitude and under conditions ranging from arid to humid. Model performance on data from the Sonoita Creek watershed was good on an annual basis (but not on a monthly basis) and in the hot seasons. To compensate for the errors in the cold seasons, advection was considered. Large errors were produced by the fact that the model neglects changes in net radiation due to surface moisture content. On an annual basis the error was 52%, and on a monthly basis it ranged from 29% in August to 111% in December. Potential evapotranspiration ranged from 60 mm per month in December to 235 mm per month in May; areal evapotranspiration, from 20 mm per month in October to 55 mm per month in May. (Cassar-FRC)
W82-01306

AUTOMATIC CLASS-A PAN-FILLING SYSTEM,
Science and Education Administration, Boise, ID. Northwest Watershed Research Center.
For primary bibliographic entry see Field 7B.
W82-01326

2E. Streamflow and Runoff

EVALUATION OF EFFECTIVE BOUNDARY ROUGHNESS FOR GRAVEL-BED RIVERS,
New Brunswick Univ., Fredericton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W82-01161

A MODEL FOR SIMULATION OF FLOW IN SINGULAR AND INTERCONNECTED CHANNELS,

Geological Survey, Reston, VA. Water Resources Div.
R. W. Schaffranek, R. A. Baltzer, and D. E. Goldberg.
Available from Supt. of Documents, GPO, Washington, DC 20402, Price, $5.00. Geological Survey Techniques of Water-Resources Investigations, Book 7, Chapter C3, 1981. 110 p, 36 Fig, 3 Tab, 17 Ref, 4 Append.

Descriptors: *Model studies, *Unsteady flow, *Networks, *Flow characteristics, Open-channel flow, Streams, Surface water, Boundary conditions, Wind tides, Seiches, Simulation, Numerical analysis, Computer programs.

A one-dimensional model is presented for simulating the unsteady flow in singular riverine or estuarine reaches and in networks and interconnected channels. The model is both general and flexible in that it can be used to simulate a wide range of flow conditions for various channel configurations. The model accommodates tributary inflow into the network channels and includes the effects of wind shear on the water-surface as a forcing function in the flow equations. Water-surface elevations and flow discharges are computed at channel junctions, as well as at specified intermediate locations within the network channels. Five example applications of the flow model are illustrated which cover such diverse conditions as a singular upland river reach in which unsteady flow results from hydropower regulations, coastal river reaches of unsteady tidal-driven flow, and a multiply connected network of channels whose flow is principally governed by wind tides and seiches in the adjoining lakes. The report includes a listing of the Fortran IV computer program and a description of the input data requirements. Model supporting programs for the processing and input of initial and boundary-value data are identified, various model output formats are illustrated, and instructions are given to permit the production of graphical output on the line printer, electromechanical pen plotters, cathode-ray-tube display units, or microfilm recorders. (USGS)
W82-01210

REGIONAL FLOOD FREQUENCY ESTIMATION AND NETWORK DESIGN,
Princeton Univ., NJ. Dept. of Civil Engineering.
N. P. Greis, and E. F. Wood.
Water Resources Research, Vol 17, No 4, p 1167-1177, August, 1981. 9 Fig, 6 Tab, 22 Ref.

Descriptors: *Flood frequency, *Regional analysis, *Network design, Probability weighted moments, Regional floods, Flood recurrence interval, *Flood forecasting.

Regional estimates of flood recurrence quantile events in gaged and ungaged basins were improved by using the probability weighted moment technique (PWM). At gaged sites PWM gave better regional estimates than the conventional methods, method of moments and maximum likelihood estimates. For ungaged basins the PWM was combined with a second method for estimating mean peak flow. Estimates were especially improved when record lengths were shorter than 20 years. The regional PWM method had an average error of 10.3% for 7 sites and 17.5% for 10 sites in Pennsylvania. Seven other ungaged methods used on the same sites had errors ranging from 25.7% to 71.1%. In an Arizona network, improvement was 9% to 31% for selected flood frequency recurrence intervals using the regression-based NARI approach. (Cassar-FRC)
W82-01294

DETERMINATION OF THE CONFIDENCE INTERVALS OF THE WAKEBY DISTRIBUTION USING ORDER STATISTICS,
Institut Nationale de la Recherche Scientifique, Sainte Foy (Quebec).
B. Bobee, and P. Boucher.
Water Resources Research, Vol 17, No 4, p 1225-1230, August, 1981. 3 Fig, 1 Tab, 18 Ref.

Descriptors: *Wakeby distribution, *Statistical analysis, *Flood frequency, Order statistics, Flood flow, Flood forecasting.

The Wakeby distribution, which accounts for the effect of separation, represents flood flows adequately. The method presented in this paper, based on the distribution of order statistics, allows determination of confidence intervals for an event of a given return period at any level for given values of the parameters. If a sample is used to estimate parameters, the procedure is approximative and may produce a small overestimation. The method is of interest in the Wakeby distribution because (1) no explicit derivation of the variation of estimation of an event with a given return period has been made, and (2) the distribution function of the order statistics can be derived in an explicit form as a result of the inverse form of the Wakeby distribution. (Cassar-FRC)
W82-01317

PHYTOPLANKTON OF FOUR RIVERS, THE TYNE, WEAR, TEES AND SWALE,
Durham Univ. (England). Dept. of Botany.
N. T. H. Holmes, and B. A. Whitton.
Hydrobiologia, Vol 80, No 2, p 111-127, May, 1981. 5 Fig, 5 Tab, 39 Ref.

Descriptors: *Ecological effects, *Rivers, *Phytoplankton, Seasonal variations, Taxonomy, Temperature effects, *England, Water transfer, Low flow, Water management, Water quality, River flow, Comparison studies.

A comparison study was made of the phytoplankton populations in four relatively fast-flowing rivers in north-east England which are associated with a water transfer scheme. The total number of live cells ranged from 200 to 20,000 cells/ml. Input of plankton from a reservoir did not influence densities at a site 25 km downstream. Diatoms formed the majority of cells in most samples, with green algae second and cryptomonads third in importance. Among the diatoms, centrics were relatively more abundant at downstream sites. The ratios of live versus dead diatoms showed marked differences with season and between centric and pennate forms. Statistics demonstrate that active growth of centric diatoms in the plankton may be important in the summer. (Baker-FRC)
W82-01376

A CATCHMENT APPROACH TO FLOOD ESTIMATION,
Northumbrian Water Authority, Gosforth (England).
D. R. Archer.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 3, p 275-289, May, 1981. 5 Fig, 11 Ref.

Descriptors: *Flood forecasting, *Gaging stations, *Catchment basins, *Northumbrian Water Authority, *Great Britain, Flood data, Flood frequency, Flood recurrence interval, Flood Studies Report, Rivers, Snowmelt, Runoff, Rainfall-runoff relationships.

Methods are presented for the determination of flood discharges of given return period at ungaged sites using catchment and geiondal flood parameters with the Flood Studies Report (1980) statistical method. Flood data from gaging stations in the Northumbrian Water Authority area and a partial duration series were used to derive standard flood parameters. Mapping these parameters revealed patterns which can be used to improve the accuracy of estimations at ungaged sites in the Northumbrian region. Some conclusions obtained from this study are: 81) flood runoffs where snowmelt is the sole contributor are potentially far more serious than is suggested by meteorological snowmelt studies; (2) the partial duration series provides data on flood behavior at low return periods, not available through the annual maximum series; (3) persistence effects produce errors in currently used partial duration series models based on a Poisson distribution of the number of exceedences within a year and an exponential distribution of the magnitude of these exceedences; (4) channel morphology and overbank storage strongly affects the distribution shape and flood growth curve; (5) drier lowland catchments have steeper growth curves than wet upland catchments in this area; and (6) adjustments based on local data can greatly improve the reliability of estimates from the Flood Studies equation. (Cassar-FRC)
W82-01397

CONCENTRATED FLOW RELATIONSHIPS,
Science and Education Administration, Tucson, AZ. Southwest Rangeland Watershed Research Center.
For primary bibliographic entry see Field 2J.
W82-01409

MONITORING GLACIER OUTBURST FLOODS,
National Hydrology Research Inst., Ottawa (Ontario). Div. of Snow and Ice.
For primary bibliographic entry see Field 2C.
W82-01558

DEBRIS FLOWS IN SMALL MOUNTAIN STREAM CHANNELS OF COLORADO AND THEIR HYDROLOGIC IMPLICATIONS,
Denver Univ., CO. Dept., of Geography.
J. E. Costa, and R. D. Jarrett.
Bulletin of the Association of Engineering Geologists, Vol. 18, No 3, p 309-322, August, 1981. 14 Fig, 2 Tab, 44 Ref.

Descriptors: *Stream erosion, *Debris cone, *Flood flow, Soil erosion, Erosion, Sediment transport, Sediment erosion, Stream gages, Channel improvement, Bank stabilization, Streamflow, Alluvial fans, Detritius, Levees, Dams, Flood profiles, Alpine regions.

Debris flows in small mountain streams have often been confused with waterfloods on gaging-station records and on-site studies. In areas of flooding due to intense rainfall, geomorphic, sedimentologic and hydraulic evidence was attributed to debris flows in five of the seven sites examined. Debris flows are identified by poorly sorted, unstratified and unconsolidated deposits having well-defined levees and terminal lobes. Although large boulders may be moved in debris flows, often small trees are not damaged. High-water marks and gaging-station records downstream show that only a small percentage of the debris-flow dishcharge is water. Mitigating actions for waterfloods such as channelization and damming may have little effect on debris flows. Debris flows in the Rocky Mountains may lead to overestimates of flood levels. This may lead to faulty values for data used in the design of flood-control structures. (Geiger-FRC)
W82-01597

2F. Groundwater

SEASONAL REVERSALS OF GROUNDWATER FLOW AROUND LAKES AND THE RELEVANCE TO STAGNATION POINTS AND LAKE BUDGETS,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
M. P. Anderson, and J. A. Munter.
Water Resources Research, Vol 17, No 4, p 1139-1150, August, 1981. 11 Fig, 2 Tab, 25 Ref.

Descriptors: *Groundwater movement, *Lakes, *Groundwater divide, Flow patterns, Stagnation point, Seasonal variation, Lake basins, Lake beds, Lake bottom springs, *Snake Lake, *Wisconsin, Flow-through lakes, Recharge, Model studies, Simulation analysis, Groundwater level, Groundwater budget.

The groundwater flow around Snake Lake, Wisconsin, was investigated with two-dimensional transient groundwater flow computer models. This flow-through lake (receives groundwater through part of the basin and recharges groundwater through the rest) showed an unusual flow system in spring 1973. A groundwater mound, i.e., an area with a water table higher than the lake surface, and a stagnation zone, which caused a reversal in the direction of groundwater flow, formed. The model simulated the changes in size and shape of the groundwater mound and the stagnation zone, as

well as the effects on the lake's water budget. The groundwater component of the lake's water budget varied from -0.014 cu ft per sec at the beginning of the simulation to +0.21 cu ft per sec 36 days later. It is likely that this flow reversal occurs every year. Factors favoring the formation of the groundwater mound and stagnation point are: location on a groundwater divide, deposits of low permeability on the downgradient side, seasonally high recharge rate, reduced thickness of aquifer under the lake, and low regional hydraulic gradient. (Cassar-FRC)
W82-01103

MASS TRANSPORT OF SOLUTES IN DUAL-POROSITY MEDIA,
Water Research Centre, Marlow (England).
For primary bibliographic entry see Field 5B.
W82-01104

SOME RECENT STUDIES ON GROUNDWATER RADON CONTENT AS AN EARTHQUAKE PRECURSOR,
Southern California Univ., Los Angeles. Dept. of Geological Sciences.
T-L. Teng.
Journal of Geophysical Research, Vol 85, No B6, p 3089-3099, June, 1980. 19 Fig, 2 Tab, 17 Ref.

Descriptors: *Radon, *Earthquakes, *Water analysis, Correlation coefficient, *Groundwater, On-site data collections, California, China, Radioactivity techniques, *Earthquake predictions.

The suggested association between radon anomalies and earthquake occurrence is discussed by reviewing experimental and field evidence. Also, the current status of groundwater radon research in relation to earthquake prediction is reviewed by the presentation of some representative studies. Experimental techniques for the detection of groundwater radon were developed in China, Japan, and the US. Radon measurement results include results from a California sampling network of 14 springs and wells. A weekly sampling program since 1974 has given an average of 3426 c/m kg. No clear correlation has been found between several small earthquake occurrences and radon variations. The extensive Chinese radon monitoring program, on the other hand, has resulted in earthquake predictions. In general, available evidence suggests an association between regional stress buildup and radon emission from crustal rocks. The discrete-sample groundwater radon measurement with the liquid N2 cold trap method has given better accuracy than continuous radon counting systems. However, it seems necessary to trade off some accuracy for the higher sampling frequency of continuous systems. (Small-FRC)
W82-01127

AN ANALYTICAL SOLUTION FOR SOLUTE TRANSPORT THROUGH FRACTURED MEDIA WITH MATRIX DIFFUSION,
National Hydrology Research Inst., Ottawa (Ontario).
G. E. Grisak, and J. F. Pickens.
Journal of Hydrology, Vol 52, No 1/2, p 47-57, June, 1981. 7 Fig, 1 Tab, 11 Ref.

Descriptors: *Solute transport, *Fracture permeability, Permeability, *Groundwater movement, Hydrology, Base flow, Infiltration, Percolation, Subsurface drainage, *Path of pollutants.

An analytical solution is presented for describing solute transport in fractured media where the solute diffuses from the fracture into the adjacent matrix. The solution is for nonreactive transport in both the fracture and the matrix. The governing conditions include one-dimensional advective transport in the fracture and one-dimensional diffusive transport, normal to the fracture, into the matrix. The utility of the solution is illustrated by applying it to laboratory data and by illustrating hypothetical cases of transport along a single fracture for large temporal and spatial scales. The Laboratory data used was derived from a column tracer test on fractured till. The retardation effect of the diffusion of the contaminant from the fracture into the matrix has important implications with regard to contaminant releases from the deep disposal or storage of toxic wastes in rock formations. For fracture water velocity, aperture and matrix diffusion coefficient of 100 meters/year, 100 micrometers and 0.000001 square centimeters/second, respectively, matrix diffusion reduces the average contaminant velocity to an exit point at 4000 meters to about 0.2% of the water velocity for media with even the least porous matrix, such as granite. (Baker-FRC)
W82-01179

GEOLOGIC AND HYDROLOGIC FACTORS CONTROLLING RADON-222 IN GROUND WATER IN MAINE,
Maine Univ. at Orono. Dept. of Civil Engineering.
W. F. Brutsaert, S. A. Norton, C. T. Hess, and J. S. Williams.
Ground Water, Vol 19, No 4, p 407-417, July/August, 1981. 11 Fig, 6 Tab, 30 Ref. OWRT-A-045-ME(4).

Descriptors: *Radon, *Granites, *Wells, *Maine, *Radioisotopes, Water analysis, Water quality, Metamorphic rocks, Pollutant identification, Water pollution sources, Groundwater, Geohydrology, Uranium, Well yield, Domestic water.

Radon-222, associated with groundwaters in uranium-containing granitic rocks in Maine, was found at concentrations up to 100,000 pCi per liter, much higher than the 500 pCi per liter recommended by the EPA. Water samples were collected from 136 granitic wells and 300 nongranitic wells in southern Maine, where the nation's top 10% incidence for some cancers occurs. The Mean Rn-222 value for groundwater from granites was 22,100 pCi per liter, range 5,000-100,000 pCi per liter; for high grade metamorphic rocks (sillimanite and sillimanite plus orthoclase), 13,630 pCi per liter, range 3,000-30,000 pCi per liter; and for low grade metasedimentary rocks (chlorite to staurolite), 1,100 pCi per liter. In granites Rn-222 increased slightly with well depth up to 50-75 meters and remained nearly constant at greater depths. Rn-222 values varied inversely with well yield and overburden thickness, and weakly inversely with Na+ values, indicative of surface water infiltration. With a given rock unit the other chemical parameters (K, Ca, Mg, Fe, Mn, Zn, and Cu) did not correlate with Rn-222 levels. (Cassar-FRC)
W82-01222

GROUND WATER,
Geraghty and Miller, Inc., Syosset, NY.
R. A. Saar, and O. C. Braids.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 921-925, June, 1981. 73 Ref.

Descriptors: *Groundwater, *Literature review, Solutes, Groundwater management, Water management, Groundwater movement, Groundwater recharge, Model studies, Nitrates, Chlorides, Organic compounds, Organic pesticides, Pesticides, Farm wastes, Leaching.

Recent developments in the area of groundwater research are cited in this literature review. Concerning water movement, studies were made of the problem of saturated-unsaturated flows in three dimensions from an injection well, examination was given to estimating the recharge of aquifers, and the numerical analysis of seepage and groundwater flow was reviewed in four sections dealing respectively with fundamental equations of seepage and groundwater flow, steady and time variant seepage, analysis of regional groundwater flow, and analysis of pumping tests. General studies on solute movement investigated waste disposal practices, leachate from landfills, and problems arising near drain fields of septic tanks. Specific solute research dealt with inorganic solutes such as calcium chloride, nitrates, and carbonates. In the area of organic sludge reports are cited which deal with the velocities of groundwater as affected by a series of homologous organic compounds, monitoring for atrazine, alachlor, and dieldrin in groundwater under farmland, ways in which viruses enter groundwater, and how soil and aquifer characteristics affect virus survival and migration rate. The importance of water reclamation through groundwater recharge was the topic of a water symposium. Groundwater resource planning was also studied heavily, with emphases on numerical models for groundwater management, mapping techniques, and specific studies of circulation of groundwater at particular sites. (Baker-FRC)
W82-01273

IDENTIFICATION OF THE WAIRAKEI GEOTHERMAL SYSTEM,
Department of Scientific and Industrial Research, Lower Hutt (New Zealand). Physics and Engineering Lab.
L. J. Fradkin.
Water Resources Research, Vol 17, No 4, p 921-927, August, 1981. 6 Fig, 1 Tab, 12 Ref.

Descriptors: *Geothermal power, *Model studies, *Wells, Thermal water, Groundwater movement, Powerplants, Wairakei, *New Zealand, Geothermal studies.

Several models describing the Wairakei geothermal system, New Zealand, were compared and the best candidates verified. The models were obtained by choosing different equations and using different parameter estimation algorithms. The least squares algorithm was found to be compatible with the chosen model structure. The identified model showed forecasting power in comparisons of predicted and observed data on pressure drops from 1969-79. The model, therefore, can be used to control the power plant, one of the oldest geothermal plants in the world. (Cassar-FRC)
W82-01312

A COMPARISON OF THE INCOMPLETE CHOLESKY-CONJUGATE GRADIENT METHOD WITH THE STRONGLY IMPLICIT METHOD AS APPLIED TO THE SOLUTION OF TWO-DIMENSIONAL GROUNDWATER FLOW EQUATIONS,
Geological Survey, Huron, SD. Water Resources Div.
L. K. Kuiper.
Water Resources Research, Vol 17, No 4, p 1082-1086, August, 1981. 3 Fig, 14 Ref.

Descriptors: Cholesky-conjugate gradient method, *Aquifers, *Transmissivity, Confined aquifers, Unconfined aquifers, *Groundwater movement, *Model studies, Comparison studies, Strongly implicit procedure.

The incomplete Cholesky-conjugate gradient method (ICCG) originally used on laser fusion problems was compared with the strongly implicit procedure (SIP) in five test problems involving steady state simulations of groundwater flow. Three were linear confined aquifer problems, and two were nonlinear water table aquifer problems. The ICCG method performed better than SIP on the confined aquifer problems and equally well on the water table problems. An ICCG iteration required 83% as much computational time as an SIP iteration. (Cassar-FRC)
W82-01315

A MATHEMATICAL MODEL OF WATER TABLE FLUCTUATION IN A SEMI-INFINITE AQUIFER INDUCED BY LOCALIZED TRANSIENT RECHARGE,
National Geophysical Research Inst., Hyderabad (India).
S. N. Rai, and R. N. Singh.
Water Resources Research, Vol 17, No 4, p 1028-1032, August, 1981. 5 Fig, 1 Tab, 11 Ref.

Descriptors: *Water table fluctuations, *Recharge, *Aquifers, *Model studies, Groundwater recharge, Groundwater movement, Reservoirs, Unconfined aquifers, Hydraulic conductivity, Specific yield.

This paper extends the work of Marino (1974), who derived an analytical model of water table fluctuation in an unconfined aquifer which is receiving localized recharge at a constant rate and is discharging into a surface reservoir. The model

presented here considers that the law of the rate of recharge decreases linearly with time and remains constant thereafter. Using three parameters (rate of recharge, hydraulic conductivity, and specific yield) it can be applied in a more general way than the pioneering study. The aquifer is defined as homogeneous, isotropic, underlain by a horizontal impermeable base, and connected with a surface reservoir on one side. The water table fluctuations caused by variations in the three parameters are described. Conclusions were: (1) the amplitude of the water table variation due to change in the rate of recharge or hydraulic conductivity is relatively larger within the zone of recharge, while the amplitude of the water table variation due to change in the specific yield continuously increases with distance beyond the zone of recharge, and (2) as hydraulic conductivity or specific yield increases, water table variations are smaller. (Cassar-FRC)
W82-01319

ORIGIN, AGE AND MOVEMENT OF PORE WATER IN AGRILLACEOUS QUATERNARY DEPOSITS AT FOUR SITES IN SOUTHWESTERN ONTARIO,
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
D. E. Desaulniers, J. A. Cherry, and P. Fritz.
Journal of Hydrology, Vol 50, No 1/3, p 231-257, March, 1981. 7 Fig, 3 Tab, 43 Ref.

Descriptors: *Groundwater dating, *Permeability, *Clays, *Ontario, *Pore water, Geohydrology, Hydraulic conductivity, Isotope studies, Waste disposal, Groundwater movement, Porous media, Dating, Diffusion coefficient.

The hydrogeologic properties of four sites in southwest Ontario were investigated to determine their suitability for waste disposal and as protective covers for regional bedrock aquifers. These locations are typical of the widespread and thick deposits of clayey till and glaciolacustrine clay. Properties measured were textural qualities, hydraulic conductivity (on the order of 10 to the minus 8th power to 10 to the minus 7th power), vertical hydraulic gradients (0.13-0.26 cm per year), and ionic and isotopic contents (O18, H2, H3, C13, and C14). Tritiated pore waters were found only within 3-6 meters of the surface, indicating that waters below this depth were recharged prior to 1952. O18 values in the pore waters were characteristic of present-day precipitation (-9 to -10%) near the surface and characteristic of much cooler waters at 20-40 meters depths (-14 to -17%). The age of the deep groundwater was determined to be 11,000 to 14,000 years. The O18, H2 and chloride concentration profiles were simulated with a model for transport by advection and diffusion in a saturated porous medium, producing effective diffusion coefficients of 3.0 times 10 to the minus 6th power sq cm per s and groundwater velocities of 0.03-0.05 cm per year. Pore water in these clay deposits is a mixture of late Pleistocene and modern waters, with the distribution of O18, H2, and chloride influenced predominantly by molecular diffusion rather than hydraulic flow. (Cassar-FRC)
W82-01321

A NUMERICAL SOLUTION FOR THE MOVEMENT OF AN INTERFACE IN A LAYERED COASTAL AQUIFER,
Technion-Israel Inst. of Tech., Haifa.
J. Bear, and I. Kapuler.
Journal of Hydrology, Vol 50, No 1-3, p 273-298, March, 1981. 7 Fig, 1 Tab, 13 Ref.

Descriptors: *Saline water intrusion, *Coastal aquifers, Groundwater movement, Aquifers, Model studies, Mathematical models, Saline-freshwater interfaces, Israel.

Seawater intrusion in a coastal aquifer is studied. In this case the aquifer is divided into several subaquifers by thin impervious layers of clay extending 1 to 3 km landward and consists of a single aquifer for the remainder of the 15 km distance from the sea. Seawater intrusion occurs as a separate advancing wedge in each of the subaquifers because of differences in freshwater discharge. Assuming that flow is normal to the coast line and horizontal in both freshwater and salt water zones, a mathematical model is stated in terms of depth to the interface in each subaquifer. Then a numerical finite difference scheme is given for solving the model in the case of a 2-layered aquifer similar to that of coastal Israel. (Cassar-FRC)
W82-01327

URANIUM ISOTOPES AS A NATURAL TRACER IN THE WATERS OF THE BET SHEAN-HAROD VALLEYS, ISRAEL,
Tel Aviv Univ. (Israel). Dept. of Geophysics and Planetary Sciences.
J. Kronfeld, and E. Rosenthal.
Journal of Hydrology, Vol 50, No 1-3, p 179-190, March, 1981. 5 Fig, 3 Tab, 10 Ref.

Descriptors: *Uranium, *Isotope tracers, *Aquifers, *Groundwater movement, Tracers, Basalts, Carbonate rocks, Bet Shean Valley, Harod Valley, *Israel, Springs, Recharge, Groundwater recharge.

Uranium isotopes were determined in 34 samples of groundwater and springs in the Bet Shean-Harod Valleys, Israel. There was little variation in uranium content (0.40-4.20 micrograms per liter), but the U234/U238 activity ratios were distributed over a wide range (1.43-3.13). A plot of uranium content vs. U234/U238 activity ratio revealed 3 distinct clusters of samples. Waters from the Revaya well field, Cenomanian carbonate aquifer (karstic), contained 1.5 micrograms per liter U and had the highest degree of isotopic fractionation. These waters were the least mineralized and the freshest of those studied. A group with low activity ratios, caused by chemical weathering, and a broader range of U distribution were found in basaltic rocks. Intermediate in isotope ratios and U content was another carbonate group. These waters were more mature and more saline than the Revays samples because of longer residence time in low permeability carbonate aquifers. (Cassar-FRC)
W82-01328

YIELD VERIFICATION OF A DOLOMITE AQUIFER IN NORTHEAST ILLINOIS,
Illinois Inst. of Natural Resources, Champaign.
R. T. Sasman, R. J. Schicht, C. R. Benson, and R. S. Ludwigs.
Ground Water, Vol 19, No 4, p 370-375, July/August, 1981. 5 Fig, 5 Ref.

Descriptors: *Groundwater budget, *Water level, *Pumpage, *Chicago, Illinois, Groundwater management, Recharge, Groundwater recharge, Carbonate aquifers, Aquifers, *Well yield.

Groundwater withdrawals in a 700 sq mile study area including DuPage County in the western Chicago metropolitan region increased 92% during 1966-1978, amounting to 61.7 mgd in 1978 (57.3 mgd from the shallow dolomite aquifer and 4.4 mgd from sand and gravel). During this period water levels declined as much as 30 ft in some areas, causing concern that groundwater recharge estimates were too low. A groundwater budget study indicated that recharge estimates were of the correct order of magnitude. Specific yield was 0.017. Pumping in excess of recharge was balanced by water removed from storage in the shallow aquifers. About 7.3 billion cu ft of dolomite and 3.3 million cu ft of sand and gravel were dewatered between 1966 and 1979. About 5.9 billion gal of water in excess of recharge has been withdrawn. Continued pumpage approaching the projected rate of 97.2 mgd for the year 2000 would withdraw 18 mgd more than the potential yield of these aquifers and severely dewater extensive areas. (Cassar-FRC)
W82-01334

GEOHYDROLOGIC MODELS OF THE HOUSTON DISTRICT, TEXAS,
Geological Survey, Lawrence, KS.
D. G. Jorgensen.
Ground Water, Vol 19, No 4, p 418-428, July/August, 1981. 8 Fig, 1 Tab, 26 Ref.

Descriptors: *Water level, *Land subsidence, *Saline water intrusion, Model studies, *Houston, Texas, *Geohydrology, *Aquifers, Clays, Compaction, Simulation analysis, Analog models, Potentiometric level, Groundwater movement.

The decline of water levels, land subsidence, and salt water intrusion in the Houston district were studied with three different models. Since this complex aquifer system is composed of discontinuous sand layers and easily compressible clay layers, land surface subsidence up to 210 cm at Pasadena and salt water intrusion at a rate of several hundred meters per year have resulted. The first electric analog model in the early 1960's simulated water level declines well in the city of Houston, but not at distances from the city. It pointed out that the available data and the two-aquifer conceptual model were not adequate for simulation of groundwater systems. There was no attempt to simulate land subsidence. The second analog model in the early 1970's, using new data, simulated water table declines in both aquifers (Chicot and Evangeline) very accurately. The distribution of land subsidence was only approximated. A digital model, developed in 1979, using five layers simulated water level declines, water from clay compaction, and land subsidence very accurately, but could not predict salt water intrusion. (Cassar-FRC)
W82-01335

COMPUTER MODELING AND GROUNDWATER PROTECTION,
GeoTrans, Inc., Reston, VA.
C. R. Faust, L. R. Silka, and J. W. Mercer.
Ground Water, Vol 19, No 4, p 362-365, July/August, 1981. 2 Tab.

Descriptors: *Model studies, *Groundwater movement, *Hydrologic models, Path of pollutants, Computer models, Regulations.

Although groundwater modeling has evolved to a high level, there is a danger that hydrologists and regulators will rely too strongly on this tool. A matrix is presented to help evaluate the reliability and credibility of models for different uses, such as quantity of groundwater available, pollutant movement in spills and at disposal sites, and seawater intrusion. The matrix uses a rating system from 0 to 4 to describe the suitability of a model for specific applications. A rating of 4 implies that a model is reliable for a particular application and that the data can be acquired at reasonable cost. A rating of 3 means that a model can be used for short-term (a few years) predictions or for general problems. Models rated 2 have not been sufficiently verified for specific issues but may be useful as conceptual tools for investigating general problems. The models rated 1 are in the evolutionary and research stage. Generally, model predictions may be extended with confidence into the future for about twice the period for which historical data are available. (Cassar-FRC)
W82-01336

AN APPROACH TO DETERMINING PATHWAYS AND RESIDENCE TIME OF GROUNDWATERS: DUAL RADIOTRACER DATING,
Physical Research Lab., Ahmedabad (India).
S. K. Gupta, D. Lal, and P. Sharma.
Journal of Geophysical Research, Vol 86, No C6, p 5292-5300, June, 1981. 9 Fig, 17 Ref.

Descriptors: *Flow velocity, *Radioactive tracers, *Tracers, *Groundwater movement, Model studies, Aquifers, Carbon radioisotopes, Silicon radioisotopes, Porous media.

Use of two radioactive tracers with widely differing half lives, Si32 and C14, was considered in a diffusion-advection equation for calculating steady state groundwater movement through porous media. This procedure is an improvement over the piston flow model, which overestimates flow velocity in highly dispersive groundwater systems, especially in the case of young water leaking into unconfined aquifers from overlying shallow aquifers. Simultaneous measurements of the two radioactive tracers can produce information flow velocity, dispersion coefficient, and leakage.

Errors in estimation of the mean dispersion time can arise from finite errors in the measurement of tracer concentrations and from finite nonradioactive loss of the tracers in the aquifer. (Cassar-FRC)
W82-01348

GROUNDWATER INVESTIGATIONS IN THE VALE OF STATHMORE,
Water Research Centre, Stevenage (England).
L. Clark.
Water Services, Vol 85, No 1023, p 219-220, May, 1981. 2 Fig.

Descriptors: *Groundwater availability, *Aquifer characteristics, *Geologic fractures, Fissure water, Geologic joints, Aquifer testing, Sandstones, Vale of Strathmore, *United Kingdom.

Various strategies are being investigated to provide supplementary water supplies for the Vale of Strathmore area. Early reconnaissance, geological, photo-geological, and existing-well surveys were performed to establish some understanding of the aquifer. A clear picture has emerged of the hydrogeology of the Old Red Sandstone. The Old Red Sandstone is acting as a regional fissured aquifer in which groundwater moves through a system of joints or bedding planes and not through intergranular voids as in a normal aquifer. Major water entry is through a fissure at 125 m from the surface. Most of the fissures seen on surface exposures must be closed at depth. The majority of wells in Strathmore are poor, and the water tends to be hard. The siting of a public-supply well should be aimed at intersecting a major fissure system. As yet, the extent of groundwater available from the aquifer has not been established. A production well is now being pumped to prove the resource. When used for a public supply, the water will have to be softened or blended. (Small-FRC)
W82-01400

A ONE-DIMENSIONAL, FINITE ELEMENT SALT WATER INTRUSION MODEL,
Guam Univ., Agana. Water Resources Research Center.
For primary bibliographic entry see Field 7A.
W82-01452

CARBON 14 DATING OF GROUNDWATER IN CONFINED AQUIFERS: IMPLICATIONS OF AQUITARD DIFFUSION,
Waterloo Univ., (Ontario). Dept. of Earth Sciences.
E. A. Sudicky, and E. O. Frind.
Water Resources Research, Vol 17, No 4, p 1060-1064, August, 1981. 4 Fig, 12 Ref.

Descriptors: *Aquitards, *Diffusion coefficient, *Dating, Groundwater movement, *Carbon radioisotopes, Confined aquifers, Aquifer systems, Tracers, Radioactive dating, Porous media, Velocity, Carbon-14.

Errors in carbon-14 dating of groundwaters in confined aquifers can be introduced by diffusive losses into fine-grained aquitards. In this theoretical analysis, a quati-two-dimensional approach is used which accounts for C14 losses by diffusion into aquitards as well as advection-dispersion transport in the aquifer. The overall effect of diffusion is to produce a slower advance of C14 along the aquifer, giving an underestimation of groundwater velocity. Errors are enhanced by small aquifer thicknesses, large diffusion coefficients, large aquitard porosity compared with aquifer porosity, and use a radioisotope with a very long half-life. Large errors are likely in stratified argillaceous aquifers unless the results are corrected for diffusion effects. The steady state distribution of C14 is relatively insensitive to the magnitude of the longitudinal dispersivity value of the aquifer, except for constituents with large half lives or for aquifers with very small groundwater velocities. An equation is presented to correct the C14 data to account for diffusion, providing the system is relatively homogeneous and stratigraphically simple. This procedure is also applicable to age dating in fractured porous media. (Cassar-FRC)
W82-01464

HYDROCHEMICAL FACIES IN A TERTIARY BASIN IN THE MILLIGAN CANYON AREA, SOUTHWEST MONTANA,
Indiana Univ. at Bloomington. Dept. of Geology.
N. C. Krothe, and M. P. Bergeron.
Ground Water, Vol 19, No 4, p 392-399, July/August, 1981. 8 Fig, 1 Tab, 12 Ref.

Descriptors: *Chemical composition, *Water quality, *Aquifers, Carbonate aquifers, Groundwater movement, *Milligan Canyon, *Montana, Anhydrite, Gypsum, Calcium bicarbonate, Sodium bicarbonate, Bicarbonates, Calcium sulfate.

Groundwater chemistry and artesian flow were studied in a synclinal basin near Three Forks, Montana, because future agricultural development in this area will increase the demand for groundwater. Water samples were collected from 29 wells and springs in the Milligan Canyon area, July 26-28, 1977, and tested for chemical parameters. Most waters in the Tertiary sediments and Madison Group carbonates are calcium bicarbonate or calcium sulfate waters, supersaturated with respect to calcite. Sodium bicarbonate waters exist in some areas. The ranges of ionic concentrations (in mg per liter) are as follows: Ca(2+), 13-246; bicarbonate, 112-328; sulfate, 29-114; and Na(+), 10-312. Flow direction is toward the east. Calcium bicarbonate waters are present in the recharge area (formed by dissolution of limestone), calcium sulfate in the center region (formed by water flowing through gypsum and/or anhydrite), and sodium bicarbonate in the discharge region (formed by cation exchange with clay minerals of volcanic origin). Decreases in concentrations of total dissolved solids and sulfate downgradient indicate sulfate reduction, followed by dilution of calcium sulfate waters by calcium bicarbonate waters originating from recharge areas to the north, northeast, and south portions of the basin. (Cassar-FRC)
W82-01481

GASEOUS NITROGEN AS EVIDENCE FOR DENITRIFICATION IN GROUNDWATER,
National Physical Research Lab., Pretoria (South Africa).
For primary bibliographic entry see Field 2K.
W82-01485

2G. Water In Soils

SCALING OF INFILTRATION BEHAVIOR IN DISSIMILAR POROUS MATERIALS,
Rothamsted Experimental Station, Harpenden (England). Dept. of Physics.
E. G. Youngs, and R. I. Price.
Water Resources Research, Vol 17, No 4, p 1065-1070, August, 1981. 9 Fig, 2 Tab, 13 Ref.

Descriptors: *Infiltration, *Soil physics, *Porous media, Soil water, Hydraulic conductivity, Capillary conductivity, Particle size.

The microscopic characteristic lengths of porous materials were obtained by three indirect methods and used in the definition of scaled variables to describe flows in their accompanying boundary conditions. The three methods used involved measurements of hydraulic conductivity at saturation, soil water pressure at half saturation, and the integral of hydraulic conductivity with soil water pressure. The porous materials tested were glass beads, washed sands, slate dust, sandy loam, and silt loam. Particle sizes varied from 2-60 micrometers in the silt loam to 350-500 micrometers in a sand. The ratios of the microscopic characteristic lengths obtained from the three methods were fairly constant between materials. Experiments with packed columns of the porous materials were used to study vertical downward infiltration, horizontal infiltration, and vertical upward capillary rise. The scaled results for these materials agreed with the theoretical predictions. This relationship may be useful in estimating soil water behavior in both dissimilar and similar porous materials, especially in field situations where soil water properties vary spatially. (Cassar-FRC)
W82-01105

STATISTICAL ANALYSIS OF THE BROOKS-COREY AND THE GREEN-AMPT PARAMETERS ACROSS SOIL TEXTURES,
Maryland Univ., College Park. School of Engineering.
R. H. McCuen, W. J. Rawls, and D. L. Brakensiek.
Water Resources Research, Vol 17, No 4, p 1005-1013, August, 1981. 4 Fig, 5 Tab, 18 Ref.

Descriptors: *Infiltration, *Soil texture, *Statistical analysis, Brooks-Corey model, Green-Ampt model, Model studies, Mathematical models, Soil water, Soil types, Silt, Clays, Loam, Hydrologic models, Error analysis.

The Brooks-Corey and Green-Ampt parameters used in infiltration equations varied significantly across the soil texture classes. Infiltration data from the literature were subjected to analysis of variance, which resulted in numerous anomalies; therefore, multivariate analysis of variance was applied. The standard errors for each soil class (clay, silt, and sand, plus all combinations) are shown in the texture triangle for the following parameters: Brooks-Corey--square root of lambda, bubbling pressure, total porosity, and soil water content; and Green-Ampt--saturated hydraulic conductivity, effective porosity, and wetting front capillary pressure term. The Duncan test was used to identify the soil texture classes for which significant differences could be identified for each infiltration model. For the Brooks-Corey model all pairs of means were significantly different at the 1% level except for (1) loam and sandy clay, (2) silt loam and clay loam, and (3) silty clay loam and silty clay. Pairs (2) and (3) are adjacent on the texture triangle; pair (1) is not. In the Green-Ampt model seven pairs were not significantly different: (1) sand and loamy sand, (2) loam and clay loam, (3) loam and sandy clay, (4) clay loam and sandy clay, (5) silty clay loam and silty clay, (6) silty clay loam and clay, and (7) silty clay and clay. All but pairs (3) and (6) are adjacent on the triangle. The parameters used in these two models are unique for each soil class and should be applied separately. The soil texture class at an ungaged site can be used in calibrating infiltration parameters. (Cassar-FRC)
W82-01107

VARIATIONS OF PH WITH ANNUAL CUMULATIVE PRECIPITATION IN ACID FOREST SOILS,
Simon Fraser Univ., Burnaby (British Columbia). Dept. of Geography.
C. B. Crampton.
Canadian Journal of Soil Science, Vol 60, No 2, p 385-387, May, 1980. 1 Fig, 7 Ref.

Descriptors: *Soil properties, *Seasonal variation, Precipitation, Acidity, Soil moisture, Moisture availability, Rain forests, *Forests, *British Columbia, *Acidic soils.

Systematic colorimetric soil pH measurements were made over an area in Belcarra Mountain in the rain forest of British Columbia. These studies were conducted over a 4 year period from 1975 to 1978. Summer values increased somewhat with total cumulative precipitation. After dry winters, lower pH values in both A and B horizons were recorded. The increase in acidification was so marked on the sandy Podzols as compared to the less light-textured Brunisols that the normal increase in pH down the profile was reversed. A substantial amount of precipitation during winter raises the water table and increases soil moisture reserves, appearing to prevent a decrease in summer pH values. It is also possible that a drying effect may have occurred during specific seasons, resulting in increased soil acidity. A summer increase in acidity would also be influenced by soil texture, as evidenced by comparing the summer pH values following the relatively wet 1975/76 winter and the relatively dry 1976/77 winter. Knowledge of the variation in soil pH values is essential for characterizing the properties of the Orthic Humo-Ferric Podzols of the area. (Baker-FRC)
W82-01118

WATER AND SALT MOVEMENT IN A SALINE-SODIC SOIL IN SOUTHERN ALBERTA,
Department of Agriculture, Lethbridge (Alberta). Research Station.
T. G. Sommerfeldt, and C. Chang.
Canadian Journal of Soil Science, Vol 60, No 1, p 53-60, February, 1980. 2 Fig, 5 Tab, 15 Ref.

Descriptors: *Soil properties, *Drainage, Seepage, Irrigation, Salts, Acidity, *Saline soils, Soil types, Water table, *Alberta, Canada.

A study was conducted on a shallow Chin loam near Vauxhall, Alberta, Canada, that had become saline-sodic, in order to better understand the internal drainage of such a system. The soil was underlain by till at 51 cm from the surface. Average water intake or infiltration for the profile was 3.76 cm/day. The Btj horizon could be a limiting layer for vertical flow. The observed horizontal hydraulic conductivity indicated that lateral flow of water in the C horizon, 36 cm/day, and in the surface of the till, 22 cm/day, could be as much as five times greater than that of Ah, 5 cm/day, and Btj, 8 cm/day, horizons. Salts were leached from the profile by application of 22 cm of water. The internal drainage of the soil was apparently sufficient to accommodate infiltrated water under normal conditions, and thus the buildup of a water table and salinization of the soil were probably due to lateral flow of water from canal seepage and irrigation mismanagement. The lateral transmission of water probably took place in the C horizon and the upper layer of till, where the horizontal hydraulic conductivity was five to seven times greater than that of the Btj and Ah horizons. The downward leaching of salts apparently was sufficient to cause the high salt buildup to occur in the Btj and C horizons rather than in the surface soil as one might expect in a semiarid, temperate climate. (Baker-FRC)
W82-01119

NITRATE REDUCTION IN AN ORGANIC SOIL-WATER SYSTEM,
Agricultural Research and Education Center, Sanford, FL.
For primary bibliographic entry see Field 5B.
W82-01129

A STUDY OF A METHOD FOR DISPLACING SOIL SOLUTION BY CENTRIFUGING WITH AN IMMISCIBLE LIQUID.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Land Resources Management.
For primary bibliographic entry see Field 5B.
W82-01131

CHANGES IN SOIL WATER QUALITY RESULTING FROM THREE TIMBER CUTTING METHODS AND THREE LEVELS OF FIBER UTILIZATION,
Montana Univ., Missoula. School of Forestry.
N. Stark.
Journal of Soil and Water Conservation, Vol 35, No 3, p 183-187, July/August, 1980. 6 Tab, 14 Ref.

Descriptors: *Forest management, *Nutrients, *Soil chemistry, *Soil water, Calcium, Copper, Iron, Potassium, Manganese, Magnesium, Sodium, Zinc, Forest soils, Clays, Trees, *Logging, *Water quality, Montana.

The effects of timber harvesting methods on soil water quality were evaluated in heavy soils (30-40% clay) in the Lubrecht Experimental Forest, Montana. Methods used were: (1) clearcutting, (2) overstory removal, and (3) understory removal. Within each harvesting method there were three levels of further utilization--slash left untouched, heavy slash removal, and burning of all slash. Nutrient losses were greater in clearcutting and overstory removal treatments. Although none of the losses were excessive, Ca, Cu, Mn, and Zn are potentially limiting in terms of total ions yet to be released. Burning caused the heaviest losses of the three slash treatments, except in the clearcut-burn combination, and reduced the amount of iron in soil water. Leaving the slash in place was least damaging. These heavy textured soils have low nutrient loss and have a biological life of 9,500 (limit of Cu supply) to 9 million years (limit of Fe supply), if only woody components are removed in a 70-year rotation. Depleted Na or Cu, and Zn or Fe toxicity will ultimately limit tree growth. There is an excess of Ca and moderate quantities of K and Mn in the forest soil water. (Cassar-FRC)
W82-01135

HYDRODYNAMIC DISPERSION DURING CONSTANT RATE ABSORPTION OF WATER BY SOIL,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
D. E. Smiles, K. M. Perroux, S. J. Zegelin, and P. A. C. Raats.
Soil Science Society of America Journal, Vol 45, No 3, p 453-458, May/June, 1981. 6 Fig, 1 Tab, 11 Ref.

Descriptors: *Flow characteristics, *Soil water, *Unsaturated flow, Hydrodynamics, Absorption, Soil science, Soil columns, Mathematical studies, Soil physics.

A group of experiments is described which explored the process of hydrodynamic dispersion during transient flow in substantially unsaturated columns at whose surface water is supplied at a constant rate. A dispersion coefficient is combined with space- and time-like variables to analyze the problem. The use of constant flux adsorption and also permits simplification of the salt flow problem. The analysis is a potentially useful technique for studying dispersion during transient water flow when the soil surface is unsaturated. The method is demonstrated using a chemically inert sandy soil. In these experiments, during transient, unsaturated flow, a simple piston flow model described the process over a range of water types. The method may also be useful in the study of the process in structured soils and when chemical reactions play an important role. (Small-FRC)
W82-01174

PREDICTION OF DIFFUSION COEFFICIENTS FROM THE ELECTRICAL CONDUCTANCE OF SOIL,
Department of Agriculture, Lethbridge (Alberta). Research Station.
C. J. Plamer, and R. W. Blanchar.
Soil Science Society of America Journal, Vol 44, No 5, p 925-929, September/October, 1980. 4 Fig, 2 Tab, 24 Ref. OWRT-A-101-MO(3).

Descriptors: *Mathematical models, *Elctrical conductivity, *Salts, Soil science, Diffusion coefficient, Cation exchange.

A two-component model was developed which used electrical conductance to predict salt movement through soil by diffusion. The model considers electrical conductance in soil to be a combination of a solution and a surface process. The diffusion coefficient for K(+) in four soils with 0.0133M KCl varied from 1.64 times 10 to the -6 power to 5.0 times 10 to the -6 power eq cm/sec when computed from electrical conductivity. It varied from 1.84 times 10 to the -6 to 0.33 times 10 to the -6 sq cm/sec when computed from self-diffusion. In the soil solution, the fraction of the electrical current carried by the 0.0133M KCl varied from 0.85 to 0.13 and was inversely related to the cation exchange capacity. Good agreement was found when diffusion coefficients estimated from the self-diffusion of 42K and 24Na in concentrated and dilute systems were compared. Diffusion measurements made by electrical conductance seem to be more reproducible than those made by self-diffusion. (Small-FRC)
W82-01224

APPORTIONMENT OF NET RECHARGE IN LANDFILL COVERING LAYER INTO SEPARATE COMPONENTS OF VERTICAL LEAKAGE AND HORIZONTAL SEEPAGE,
Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
J. J. Lentz.
Water Resources Research, Vol 17, No 4, p 1231-1234, August, 1981. 3 Fig, 1 Tab, 2 Ref.

Descriptors: *Soil water, *Leachates, *Infiltration, *Landfills, Path of pollutants, Groundwater, Recharge, Seepage, Drainage, Input-output analysis, Runoff.

Equations are developed to determine the water surplus in a sloping cover placed over an aboveground landfill. The water surplus in the cover is separated into vertical leakage and lateral seepage fractions using input-output analysis. The hypothetical landfill contains multiple cells 40 feet high, covered with 0.5 to 3 ft of soil, with cell surfaces sloped toward a centerline drain which removes surface water and seepage without backwater effects. This procedure allows calculation of the quality of soil water penetrating the landfill cover and thus the quantity of leachate, an important factor in the study of groundwater pollution. An example of a typical landfill is given in which 0.36 cm of soil moisture becomes available the first day and 0.05 cm more on the second day. The amounts of water accumulating in the cover layer, leaking into the waste, and seeping into the drain are calculated for each day. After 4 days the cover layer is dry, 0.313 cm has leaked to the waste, and 0.096 cm has seeped into the drain. (Cassar-FRC)
W82-01298

MEASURING THE HYDRAULIC CONDUCTIVITY OF SOIL ADJACENT TO TILE DRAINS IN A HEAVY CLAY SOIL IN THE NETHERLANDS,
Soil Survey Inst., Wageningen (Netherlands).
J. Bouma, J. W. Van Hoorn, and G. H. Stoffelsen.
Journal of Hydrology, Vol 50, No 1/3, p 371-381, March, 1981. 5 Fig, 3 Tab, 6 Ref.

Descriptors: *Hydraulic conductivity, *Tile drains, *Soil compaction, Drains, Clays, *Netherlands, Infiltration, Soil water, Percolation rate.

A new technique for measuring hydraulic conductivity was applied to heavy clay soils adjacent to tile drains. The method involves excavation of a cube of soil 25 cm on a side around a drain tile. The tile is cut so that the two ends each protrude 5 cm from the cube. Then the cube is removed from the site and covered on five sides with gypsum, which is allowed to harden. The cube is turned upside down and infiltration measured from the exposed surface. Then this surface is covered with gypsum, the opposite surface uncovered, and the measurements repeated. These measurements are characteristic of the undisturbed soil below the drain and the fill soil above the drain, respectively. Methylene blue added to the percolating water traces patterns of water movement. Tests of 12 cubes of soil and three types of pipes (fired clay, slotted plastic, corrugated plastic) showed average hydraulic conductivity values of 10 meters per day for soil below the drain and 5 meters per day above the drain. Dye studies indicated that water movement was almost exclusively along cracks, not rootholes. (Cassar-FRC)
W82-01323

REMOTE SENSING OF SOIL MOISTURE CONTENT OVER BARE FIELD AT 1.4 GHZ FREQUENCY,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 7B.
W82-01345

DETERMINATION OF SOLUTION ELECTRICAL CONDUCTIVITY FROM BULK SOIL ELECTRICAL CONDUCTIVITY MEASUREMENTS BY THE FOUR-ELECTRODE METHOD,
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Div. of Soil Physics.
A. Nadler, and H. Frenkel.
Soil Science Society of American Journal, Vol 44, No 6, p 1216-1221, November-December, 1980. 3 Fig, 5 Tab, 24 Ref.

Descriptors: *Conductivity, *Salinity, *Soil water, *Electrical properties, Soil physical properties, Soil chemistry, Mathematical studies, Resistivity.

A proposed linear relationship between soil electrical conductivity and soil water electrical conductivity was valid only at high salinities, greater than 4 mmho per cm, when measured by the four-electrode method. At low salinity levels, the surface conductance was not constant and made a higher contribution than soil water electrical conductivity to measured soil electrical conductivity. A method for correcting this inadequacy used the Waxman-Smits equation. Comparisons between theoretical and experimental soil electrical conductivity values for low salinities showed agreement. (Cassar-FRC)
W82-01458

NITROGEN LEACHING AS INFLUENCED BY NITROGEN MANAGEMENT AND SUPPLEMENT IRRIGATION LEVEL,
Scientific and Education Administration, Morris, MN. North Central Soil Conservation Research Lab.
For primary bibliographic entry see Field 5B.
W82-01472

SPATIAL VARIABILITY OF STEADY-STATE INFILTRATION RATES AS A STOCHASTIC PROCESS,
New Mexico Agricultural Experimental Station, Las Cruces.
J. B. Sisson, and P. J. Wierenga.
Soil Science Society of America Journal, Vol 45, No 4, p 699-704, July/August, 1981. 9 Fig, 1 Tab, 22 Ref.

Descriptors: *Stochastic processes, *Infiltration rate, Sampling, *Soil properties, Spatial distribution, Statistical analysis, *Soil water.

Autocorrelation was estimated between field-measured infiltration rates to show how this correlation affects the variance of composited samples. Space series analysis was used. Steady-state infiltration rates were measured with infiltrometers of 5, 25, and 127 cm inside diameter in a field plot. Infiltration rates were lognormally distributed for all ring sizes and autocorrelated for the 5-cm ring size. A power spectrum was computed for each of the realizations to a lag of 40. Most of the variance among observations occurred at lower frequencies or at large distances between samples. The results supported the hypothesis that sampling variance is a function of distance between observations. Recommendations include sampling in space and repeated sampling in time to detect treatment effects. For sampling a field for some attribute, the samples should be from widely dispersed locations. For sampling repeatedly in time, several dispersed samples should be composited and the exact location of each marked permanently. At the next hold effects of spatial variability to a minimum. (Small-FRC)
W82-01560

HYDRAULIC PROPERTIES OF FULLERTON CHERTY SILT LOAM,
Oak Ridge National Lab., Environmental Sciences Div.
R. J. Luxmoore, T. Grizzard, and M. R. Patterson.
Soil Science Society of America Journal, Vol 45, No 4, p 692-698, July/August, 1981. 7 Fig, 3 Tab, 13 Ref.

Descriptors: *Permeability coefficient, *Soil properties, *Loam, *Soil water, Tensiometers, Watersheds, Measuring instruments, Hydrology, Walker Branch Watershed, Tennessee.

A field drainage study was established on Fullerton cherty silt loam as a component of the hydrologic characterization of Walker Branch Watershed in eastern Tennessee. Soil water content was monitored after the soil was saturated and during free drainage using a neutron probe at depths of 10, 28, 37, 47, 89, 117, and 177 cm. The changes in water content and matric potential with time and the laboratory data on retention properties of soil cores were used to calculate the hydraulic conductivity. The data are tabulated. Field plot tensiometer results could not be clearly interpreted because of poor correspondence between tensiometer and neutron probe measurements at any given depth. The small-diameter tensiometer cups grouted into aggregated clay subsoil were not suitable for the determination of hydraulic gradient or field retention characteristics. They may be useful in determining soil macroporosity when used in combination with neutron probe measurements. The maximum hydraulic conductivity derived by the instantaneous profile method was 58 to 177 cm per day for two locations. (Small-FRC)
W82-01561

SUPER SLURPER EFFECTS ON CRUST STRENGTH, WATER RETENTION, AND WATER INFILTRATION OF SOILS,
Oklahoma State Univ., Stillwater. Dept. of Agronomy.
P. Hemyari, and D. L. Nofziger.
Soil Science Society of America Journal, Vol 45, No 4, p 799-801, July/August, 1981. 1 Fig, 2 Tab, 10 Ref.

Descriptors: *Soil water, *Infiltration, Soil properties, Sand, Clays, Soil strength, Super slurper, Soil amendments, Soil absorption capacity, Soil water retention, Soil crust strength.

The effect of hydrolyzed starch polyacrylonitrile graft copolymer, commonly called super slurper, on soil crust strength, soil water retention, and infiltration rate was investigated for three soils. Soils were a Teller sandy loam, a Tillman-Hollister clay loam, and a Cobb loamy sand. The modulus of rupture decreased significantly for each soil as the rate of super slurper use increased. A multiple range test was used to compare the water contents of six different soil treatments at each of six suctions for each soil. Tillman-Hollister clay loam had increased water retention after super slurper treatment. Super slurper at rates of 0.025, 0.5, and 0.1% did not increase water retention in Teller sandy loam or Cobb loamy sand. Super slurper decreased the rate of water entry into all three soils. Thus, super slurper has the potential for modifying soil properties, although additional research is needed to determine the longevity of the treatment effects under field conditions. (Small-FRC)
W82-01562

2H. Lakes

AN EXAMPLE OF THE APPLICATION OF STATISTICAL TECHNIQUES TO PREDICT LAKE LEVEL ELEVATIONS,
Department of the Environment, Edmonton. Div. of Design and Construction.
For primary bibliographic entry see Field 6A.
W82-01111

A QUANTITATIVE STUDY OF SHORELINE MARSH COMMUNITIES ALONG LAKE HURON IN ONTARIO,
University of Western Ontario (London). Dept. of Plant Sciences.
D. Fahselt, and M. A. Maun.
Canadian Journal of Plant Science, Vol 60, No 2, p 669-678, April, 1980. 3 Fig, 4 Tab, 13 Ref.

Descriptors: *Lake Ontario, Lakes, *Marshes, *Nuclear powerplants, Powerplants, Shoreline cover, Vegetation, Coastal marshes, Wetlands, Swamps, Nuclear reactors, Heated water, Plumes, *Thermal pollution, Temperature effects, *Ontario.

Ten marshes along the east coast of Lake Huron were surveyed. All ten were open to the influence of the lake. The lake bottom sloped away gradually from all marshy sites, and offshore the water depth was less than 2 meters for a distance of about 0.4 km. All had a basically westerly exposure, included a homogeneous area of 800 square meters or more and showed little or no evidence of human disturbance. Two Baie du Dore marshes selected for study were each treated as two separate homogeneous areas. The mean dry weight of each plant species found was determined per unit area in every marsh, and the diversity and dominance indices were calculated. Application of the sums of squares agglomeration technique showed that the two northernmost sites were the most distinctive floristically. Three of the more southern marshes located near the Bruce Nuclear Power Development clustered together into a separate group. Clustering of marshes cannot be expected to reveal whether the species composition of marshes near the power development has been affected by thermal discharges, since baseline studies had not been conducted before the plant was built. It is expected that heated effluents may cause some changes in vegetation. It is suggested that a resurvey of the area in the vicinity of the power plant be conducted in a few years when both reactors are working at full capacity. Submerged hydrophytes offshore should also be studied. (Baker-FRC)
W82-01122

CHANGES IN LAKE ONTARIO TOTAL PHOSPHORUS CONCENTRATIONS, 1976-1978,
Canada Centre for Inland Waters, Burlington (Ontario); and National Water Research Inst., Burlington (Ontario). Aquatic Physics and Systems Div.
A. S. Fraser.
Journal of Great Lakes Research, Vol 6, No 1, p 83-87, 1980. 1 Fig, 3 Tab, 13 Ref.

Descriptors: *Phosphorus, *Seasonal variation, Lakes, Fate of pollutants, *Lake Ontario, Water quality, Sedimentation, Phytoplankton.

Lake Ontario's total phosphorus levels, which normally show a high peak in spring and an abrupt drop in late summer, were about 4 micrograms P per liter lower than expected in 1977 and 1978. Spring phosphorus levels for the whole lake were approximately 19.5 micrograms per liter in 1977 and 20.0 micrograms per liter in 1978, compared with the 1976 value, about 23.5 micrograms per liter. Loading reduction for this period accounted for only 10% of the change. The probable explanation for the lower P levels is a change in sedimentation rate of total P, such as caused by the death and sedimentation of a large phytoplankton crop just prior to overturn. It is unknown whether the lower P levels in 1977 and 1978 reflect a downward trend or whether new seasonal patterns have been established. (Cassar-FRC)
W82-01126

PETROLEUM HYDROCARBONS IN SEDIMENTS OF SAGINAW BAY, LAKE HURON,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
For primary bibliographic entry see Field 5A.
W82-01141

FERROMANGANESE NODULES FROM LAKE ONTARIO (BAY OF QUINTE): MINOR ELEMENT GEOCHEMISTRY,
University of Western Ontario (London). Dept. of Geology.
W. S. Fyfe, B. I. Kronberg, M. Peirce, and G. G. Leppard.
Journal of Great Lakes Research, Vol 6, No 3, p 203-209, 1980. 1 Fig, 3 Tab, 38 Ref.

Descriptors: *Trace elements, *Nodules, *Geochemistry, Lakes, Lake sediments, Sediments, *Lake Ontario, Ferromanganese nodules, Chemical analysis.

Ten ferromanganese nodules found in eastern Lake Ontario in the Bay of Quinte near Glenora were analyzed by spark source mass spectroscopy. Concentrations of 51 minor elements were compared with those in ferromanganese concretions from other lakes, the marine environment, and the earth's crust. Levels of minor elements were: Ba, 1%; Sr, 0.1%; F, S, Co, Zn, and La, 100 micrograms per g range; and others, 1-100 micrograms per g. Compared with marine nodules, lake nodules contained lower levels of all minor elements except Ge and were amorphous rather than crystalline. Lake nodules in this area are found in water depths of 4-8 meters and therefore have not been

exposed to water volumes as great as those in the marine environment. (Cassar-FRC)
W82-01143

A SURVEY OF ATP CONCENTRATIONS IN LAKE ONTARIO, 1975-1976,
Canada Centre for Inland Waters, Burlington (Ontario).
M. MacKinnon, and R. E. Kwiatkowski.
Journal of Great Lakes Research, Vol 6, No 3, p 177-183, 1980. 7 Fig, 3 Tab, 21 Ref.

Descriptors: *Biomass, *Adenosine triphosphate, Microorganisms, Lakes, *Lake Ontario, Chlorophyll a, Seasonal variation, Phosphorus, Organic carbon, Particulate matter, Microbiological studies.

Total microbial biomass concentrations of Lake Ontario were estimated by the adenosine-5'-triphosphate (ATP) technique for three seasons in 1975-1976. The inshore waters had a mean integrated ATP concentration of 0.142 mg per cu meter in December and 0.189 mg per cu meter in April; offshore waters, > 0.050 mg per cu meter. There was no significant difference between surface samples (0-20 meters) and bottom samples. In August, the surface layer had a mean ATP concentration of 0.452 mg per cu meter, bottom inshore waters, 0.238 mg per cu meter, and mid-water samples, 0.040 mg per cu meter. The ATP/particulate organic carbon ratio was relatively constant throughout the lake in winter and spring, but increased in summer, while the chlorophyll/particulate organic carbon ratio was constant with the season. The stepwise regression technique showed that ATP variability was explained in winter-spring by chlorophyll a and in summer by phosphorus. (Cassar-FRC)
W82-01144

A CLASSIFICATION AND DESCRIPTION OF SOME NORTHEASTERN ONTARIO LAKES INFLUENCED BY ACID PRECIPITATION,
Laurentian Univ., Sudbury (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 5B.
W82-01145

SOLUBLE ELEMENT CONCENTRATIONS AND COMPLEXATION IN SOUTHEASTERN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
R. Rossmann.
Journal of Great Lakes Research, Vol 6, No 1, p 47-53, 1980. 6 Tab, 16 Ref.

Descriptors: *Trace elements, *Solubility, *Chelation, Hypolimnion, Epilimnion, Lakes, Water quality, *Lake Michigan, Minerals.

Water samples were collected from both epilimnion and hypolimnion of nearshore southeastern Lake Michigan near the Donald C. Cook Nuclear Plant during 1974 and 1975. The mean elemental soluble (< 0.45 micrometers) concentrations in log(moles per liter) for the 88 epilimnion samples were: Ba, -6.5; Ca, -3.1; Co, -7.7; Cr, -7.5; Cu, -7.4; Fe, -6.9; K, -4.5; Mg, -3.3; Mn, -8.1; Mo, -6.9; Na, -3.6; Ni, -6.9; Sr, -5.9; Zn, -7.1; Cl, -3.5; soluble reactive phosphate-P, -7.5; sulfate, -3.7; and soluble reactive silica, -5.3. Values for the hypolimnion were similar except for soluble reactive silica, which was more concentrated in the hypolimnion in July of 1974 and 1975. Ions with more than 10% of their activity accounted for by complexes were: Co(2+), Cu(2+), Fe(3+), Mn(2+), Ni(2+), carbonate, sulfate, and phosphite. These estimates were obtained from thermodynamic data and solving simultaneous equations. During July 1974 the epilimnion was supersaturated with respect to dolomite, malachite, hydroxyapatite, fluoroapatite, hydroxoapatite, X-ray amorphour (Fe(OH)3, and goethite. It was undersaturated with respect to calcite, aragonite, rhodochrosite, barite, and strengite. (Cassar-FRC)
W82-01147

PHOSPHORUS UPTAKE DYNAMICS AS RELATED TO MATHEMATICAL MODELING OF CLADOPHORA AT A SITE ON LAKE HURON,
Michigan Univ., Ann Arbor.
For primary bibliographic entry see Field 5C.
W82-01149

HYPOLIMNION FLOW BETWEEN THE CENTRAL AND EASTERN BASINS OF LAKE ERIE DURING 1977 (INTERBASIN HYPOLIMNION FLOWS)
Canada Centre for Inland Waters, Burlington (Ontario); and National Water Research Inst., Burlington (Ontario).
F. M. Boyce, F. Chiocchio, B. Eid, F. Penicka, and F. Rosa.
Journal of Great Lakes Research, Vol 6, No 4, p 290-306, 1980. 12 Fig, 4 Tab, 12 Ref.

Descriptors: *Oxygen transfer, *Lake basins, *Hypolimnion, *Water circulation, Dissolved oxygen deficit, *Lake Erie, Water currents, Lakes, Lake morphology, Interbasin transfers, Wind-driven currents, Water currents.

The two basins of Lake Erie (eastern basin, mean depth 28.5 m, and central basin, mean depth 19 m) are separated by the Pennsylvania Ridge, extending southward between the base of Long Point, Ontario to Erie, Pennsylvania. This ridge lies at 15 m depth except for a narrow 24 m deep notch. During 1977 data from ship cruises and from a network of current meters installed on and near the ridge were collected to estimate the hypolimnion flux across the sill area. A strong correlation between winds and mean flux was observed. The dynamic balance appear to be one in which the surface pressure gradient created by wind stress is opposed by internal pressure gradients and by bottom friction. Two major bursts of transport from the deeper eastern basin to the shallower central basin hypolimnion occurred, mid-June to mid-July (13 cu km of water or 20-25% of the hypolimnion volume) and July 31-August 13 (7 cu km of 17% of the hypolimnion volume). Both of these transfers were associated with persistent east winds. The August event was important in transferring dissolved oxygen to the central basin's hypolimnion during the summer oxygen depletion period, raising the mean concentration oxygen in the central basin between 0.5-1.0 mg per liter, or a quarter to a half of the oxygen demand of the central basin hypolimnion. However, this oxygen enrichment does not reach the western 2/3 of the central basin. (Cassar-FRC)
W82-01153

FATTY ACID AND HYDROCARBON CONTENT OF SETTLING SEDIMENTS IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
P. A. Meyers, S. J. Edwards, and B. Eadie.
Journal of Great Lakes Research, Vol 6, No 4, p 331-337, 1980. 4 Fig, 1 Tab, 24 Ref.

Descriptors: *Lake sediments, *Hydrocarbons, *Fatty acids, Organic compounds, *Lake Michigan, Algae, Bacteria, Lakes, Sedimentation, Organic matter, Particulate matter, Aquatic plants, Zooplankton, Phytoplankton.

Sediments were collected in traps suspended at three depths (35 m, 73 m, and 82 m) in southeast Lake Michigan near the Grand River mouth. The lake depth at this point was 83 m and the metalimnion/hypolimnion boundary at 35 m. Fatty acid concentrations were (in mg per g sediment from shallowest to deepest sample, respectively) 9.8, 5.3, and 1.7, indicating active microbial reworking and dilution by resuspended sedimentary materials. Distributions of the straight chain acids were similar in all three samples, dominated by C14, C16, and C18 acids characteristic of algae and bacteria and aquatic plants. The hydrocarbon concentrations at the three depths (micrograms per g sediment, shallowest to deepest sample, respectively) were 147.6, 35.8 and 53,4. Distributions of hydrocarbons differed markedly at the various depths. The 35 m sample had large amounts of C17-C31, typical of terrigenous plants. The two deeper samples were dominated by C27-C31 and had little C17-C19 hydrocarbons. Petroleum may be a source of some of the hydrocarbons in the 35 m sample, whereas resuspended sediments dilute the organic content of the trapped sediment at lower depths. Estimated fluxes to the bottom of the lake in this area are organic carbon, 6.59 g per sq m; fatty acids, 1.8 g per sq m and aliphatic hydrocarbons, 27 mg per sq m. (Cassar-FRC)
W82-01154

WAVE CLIMATE AND POTENTIAL LONGSHORE SEDIMENT TRANSPORT PATTERNS, NOTTAWASAGA BAY, ONTARIO,
Guelph Univ. (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W82-01156

A BIOASSAY STUDY OF EFFECTS OF ZOOPLANKTON, IRON AND NTA ON THE PHYTOPLANKTON PRODUCTIVITY OF A MARL LAKE,
Michigan State Univ., Hickory Corners. W. K. Kellogg Biological Station.
S. F. Mitchell, and R. G. Wetzel.
Hydrobiologia, Vol 68, No 3, p 235-241, February, 1980. 2 Fig, 4 Tab, 26 Ref.

Descriptors: *Phytoplankton, *Zooplankton, *Iron, *Nitrilotriacetic acid, Productivity, *Lakes, Lawrence Lake, Gull Lake, *Michigan, Chelation, Grazing, Daphnia.

Additions of nitrilotriacetic acid (NTA) and iron (in the form of FeC13) to water samples from two calcareous Michigan lakes (Lawrence and Gull) slightly stimulated phytoplankton producivity in autumn and winter. The two chemicals were added in all possible combinations of 0, 10 or 50, 100, and 200 mg per cu meter and incubated up to 168 hours. These results contrasted with a 4-fold increase in productivity found during in situ studies on marl lakes in the summer. Greatest increases in productivity were 20 and 37% at 96 hour and 168 hours, respectively, using NTA alone. In other experiments with Fe and NTA the greatest response was 5%. Daphnia pulex added to cultures reduced phytoplankton productivity by half for every 20-30 animals per liter present. Reductions were seen at all levels of addition--from 4 to 32 animals per litter. In summer up to 150 Daphnia per liter were required to halve the phytoplankton production. Possible reasons for the seasonal differences are the differences in species composition, microflagellates dominating in winter and diatoms, green algae and blue-green algae in summer. In addition, phytoplankton productivity responds much more strongly to temperature than do D. pulex filtering rates; winter zooplantkton grazing rates (8-10% per day) were on the same order as winter phytoplanton renewal rates (2-10%). (Cassar-FRC)
W82-01157

BIOGEOCHEMICAL INVESTIGATION OF BIG CREEK MARSH, LAKE ERIE, ONTARIO,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
A. Mudroch.
Journal of Great Lakes Research, Vol 6, No 4, No 4, p 338-347, 1980. 1 Fig, 6 Tab, 23 Ref.

Descriptors: *Marshes, *Water quality, *Sediments, Wetlands, *Big Creek Marsh, *Lake Erie, Ontario, Nutrients, Metals, Aquatic plants, Insecticides, DDT, Polychlorinated biphenyls, Pollutant identification, Fate of pollutants.

Sediment composition, nutrient and metal uptake by macrophytes, and nutrient and metal concentrations in water were studied at 6 stations in the 850 ha Big Creek Marsh, Ontario. Concentrations of Mg, Ca, Na, K, Mn, and P in surface sediments were similar at all stations with the exception of 20.95% Ca dry weight at a site covered with Elodea, which accumulates Ca. Marsh sediments were lower in Pb, Cu, Ni, and Cr than Lake Erie sediments (highest values in micrograms per g sediment dry weight: 86, 38, 48, and 119, respectively). Several samples exceeded Lake Erie

values: Zn, 1 sample, 383 micrograms per g; As, 2 samples, 64 and 112 micrograms per g; and Hg, 2 samples, 0.930 and 0.530 micrograms per g. Up to 0.018 micrograms per g p,p'-DDE and 0.013 micrograms per g p,p'-TDE, both DDT metabolites, and maximum of 0.51 micrograms per g polychlorinated biphenyls were found in sediment samples. Maximum concentrations of metals (mg per liter) in marsh water samples were: Cu, 0.078; Pb, 0.001; Ni, 0.001; and Zn, 0.018. Increases of total Kjeldahl N and ammonium-N were seen in some marsh water samples in November. This was ascribed to decomposition of some macrophytes. Submerged plants, Myriophyllum, Chara, and Elodea sp, accumulated larger quantities of Pb, Cu, Ni, Cr, and Cd than emergent plants. Ca accumulating plants had higher levels of Pb, Cu, Ni, Cr, and Cd, but Zn levels showed no correlation. (Cassar-FRC)
W82-01163

PHYTOPLANKTON PRODUCTIVITY AND STANDING CROP IN THE VICINITY OF THE LAKE HURON-SAGINAW BAY FRONT,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
R. A. Moll, C. O. Davis, and C. L. Schelske.
Journal of Great Lakes Research, Vol 6, No 3, p 232-246, 1980. 7 Fig, 3 Tab, 41 Ref.

Descriptors: *Phytoplankton, *Interfaces, *Eutrophication, Bays, *Lakes, Lake Huron, *Saginaw Bay, Chlorophyll a, Productivity, Nutrients, Phosphorus, Seasonal variation, Path of pollutants.

The front or interface between eutrophic Saginaw Bay water and oligotrophic Lake Huron water was located by continuous underway sampling at 1 m depth during four research cruises. Samples were analyzed for temperature, nutrients, and chlorophyll distributions. Chloride was a reliable indicator of the front, which was highly mobile. Subsequently, stations in the bay and lake were established for further sampling. Phytoplankton production began earlier in the spring in the warmer, more eutrophic bay water than in the cold, open lake water. There was less difference in phytoplankton densities by late summer. Comparing water quality by t-tests showed that the conservative variables (temperature, chloride, and extinction coefficient) and chlorophyll a and total phosphorus showed highly significant differences between bay and lake water, less significant differences between interfaces and lake, and no difference between bay and interface. Silicate, pH, and C14 uptake had significant differences between bay and interface, but not between lake and interface. The phytoplankton community at the nutrient interface had high chlorophyll a biomass (4.47 micrograms per liter), low C14 uptake (7.12 micrograms per liter per hour) and high bacterial activity (V max, 1.33), indicating the presence of a senescent assemblage. Much of the phytoplankton in the bay was removed from the water column by decomposition and settling before mixing into the open lake. However, during mid-summer several large outputs of nutrients and/or phytoplankton from bay to lake were observed. Although total phosphorus moved readily across the front, chlorophyll biomass did not. (Cassar-FRC)
W82-01164

POSTSPAWNING MORTALITY OF RAINBOW SMELT IN WESTERN LAKE SUPERIOR,
Brigham Young Univ., Provo, UT. Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W82-01189

ORGANOCHLORINE INSECTICIDES AND PCB IN SURFICIAL SEDIMENTS OF LAKE MICHIGAN (1975),
Ontario Ministry of Agriculture and Food, Guelph. Pesticide Residue Lab.
For primary bibliographic entry see Field 5A.
W82-01190

TRACE METAL MINERAL EQUILIBRIA IN LAKE ERIE SEDIMENTS,
Case Western Reserve Univ., Cleveland, OH. Dept. of Geological Sciences.
G. Matisoff, A. H. Lindsay, S. Matis, and F. M. Soster.
Journal of Great Lakes Research, Vol 6, No 4, p 353-366, 1980. 3 Fig, 3 Tab, 76 Ref.

Descriptors: *Chemical precipitation, *Lake sediments, *Trace metals, *Lake Erie, Sediments, Lakes, Saturation index, Pore water, Sulfides, Phosphates, Minerals, Carbonates, Fate of pollutants, Zinc, Cadmium, Calcium, Iron, Manganese, Lead.

An ion pair model of interstitial water chemistry of Lake Erie sediments was used to calculate the thermodynamic precipitation tendency of metal phosphate and carbonate mineral phases. It is suggested that detrital calcite, aragonite, and dolomite are dissolving and Fe and Mn carbonates are precipitating. Regenerated phosphate should be removed from solution by reacting with Ca, Fe, Mn, and Pb, with whitlockite, Ca3(PO4)2, being the predicted primary controlling phase. Apatites are supersaturated and may be precipitating. The most probable controlling mechanisms for Zn and Cd are sulfide phases, mixed mineral phases, adsorption, and/or ion exchange equilibria. Inclusion of organic complexes in the model would not improve the results significantly, except for slight reductions in predicted supersaturation.(Cassar-FRC)
W82-01191

SEASONAL FEATURES OF ZOOPLANKTON ASSEMBLAGES IN THE NEARSHORE AREA OF SOUTHEASTERN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
M. S. Evans, B. E. Hawkins, and D. W. Sell.
Journal of Great Lakes Research, Vol 6, No 4, p 275-289, 1980. 4 Fig, 8 Tab, 45 Ref.

Descriptors: *Zooplankton, *Seasonal variation, *Water depth, Lakes, *Lake Michigan, Plankton, Phytoplankton, Fish, Predation, Invertebrates.

Abundance of zooplankton within 11 km north, south, and offshore from the Donald C. Cook Nuclear Power Plant, southeastern Lake Michigan, varied with year, season, and depth during the period 1971-77. Results demonstrate that long-term changes in zooplankton populations can be documented convincingly only if comparisons are made in similar areas of the lake at the same time of year. Zooplankton assemblages were strongly related to water depth from mid-spring to mid-autumn. The shallowest zone studied, 5-10 m, had the least abundance and most variability in zooplankton populations. From mid-spring to mid-autumn zooplankton abundance in the 5-10 m zone was lower; after destratification, higher. Densities were low in spring (<10,000 per cu meter) and highest in summer (>50,000 per cu meter) and declined through autumn. During autumn the inshore region was dominated by cladocerans and the outer region by copepods. Factors implicated in the seasonal variations are temperature regimes, phytoplankton standing stocks, and predation. (Cassar-FRC)
W82-01192

EFFECTS OF ATMOSPHERIC PRECIPITATION ADDITIONS ON PHYTOPLANKTON PHOTOSYNTHESIS IN LAKE MICHIGAN WATER SAMPLES,
Argonne National Lab., IL.
J. I. Parker, G. T. Tisue, C. W. Kennedy, and C. A. Seils.
Journal of Great Lakes Research, Vol 7, No 1, p 21-28, 1981. 4 Fig, 3 Tab, 35 Ref.

Descriptors: *Lakes, *Phytoplankton, Aquatic plants, Plankton, Phytotoxicity, Zinc, Cadmium, Copper, *Precipitation, *Lake Michigan, Phosphates, Nitrates, Nutrients, Ammonia, Photosynthesis.

Chemical analyses were made of local precipitation in the Lake Michigan area. The effects of incremental additions of rain or snow-melt water on the photosynthetic rate of phytoplankton from the offshore water of Lake Michigan were also investigated. In three of the four experiments conducted, wet deposition was used, and in one experiment a melted snow core was used as the incremental addition. Photosynthesis was significantly increased in three experiments. In the other experiment, photosynthesis was greater than in control samples, and this precipitation sample appeared to stimulate primary productivity. Lake water averages for phosphate, nitrate, and ammonia concentration were exceeded in the precipitation samples by factors of 10, 2, and 50, respectively. Precipitation levels of silicon were lower than the concentration in lake water, but this apparently did not limit photosynthesis. Acidity of lake water was reduced only slightly by added precipitation, and no consistent relationship between these slight reductions in acidity and reduced photosynthesis could be established. Treated samples showed very significant reductions in alkalinity. Levels of zinc, cadmium, and copper in the precipitation samples greatly exceeded the lake water averages, thus producing a high potential for toxic effects on photosynthesis at treatment levels greater than 10%. The results suggest that algal nutrients and toxic trace elements in atmospheric precipitation may interact in a competitive manner to either stimulate or depress phytoplankton photosynthesis in water samples from Lake Michigan. (Baker-FRC)
W82-01196

SEDIMENT DISTRIBUTION OF METHANOGENIC BACTERIA IN LAKE ERIE AND CLEVELAND HARBOR,
Ohio State Univ., Columbus. Dept. of Microbiology.
T. E. Ward, and J. I. Frea.
Applied and Environmental Microbiology, Vol 39, No 3, p 597-603, March, 1980. 2 Fig, 3 Tab, 30 Ref. OWRT-A-040-OHIO(2).

Descriptors: *Sediments, *Bacteria, Cleveland Harbor, *Lake Erie, *Harbors, Fluorescence, Methane bacteria, Seasonal variation, *Sediment distribution.

Results are presented from a survey made with fluorescent-antibody techniques of the seasonal and sediment distribution of a select number of known methanogens which occur naturally in the sediments of Lake Erie and Cleveland Harbor. The most numerous methanogen found in regions of high-organic-silt sediments was Methanobacterium ruminatium. The population of this species ranged from 10 to the 6th power to 10 to the 9th power cells/gram of dry sediment. Identifications were made in sand-silt, clay, or sand sediments of Methanobacterium strain MoH and Methanosarcina barkeri. These methanogens ranged in density from 10 to the 6th power to 10 to the 7th power cells/g of dry sediment. Methanospirillum hungatii was noted only after an organic enrichment was done on Cleveland Harbor sediments. The seasonal and selective sediment distribution of these methanogens appears related to the type and concentration of carbon substrate as well as to the activities of heterotrophic and sulfate-reducing bacteria. The application of the fluorescent antibody technique to these naturally occurring methanogens should increase the acquired knowledge of aquatic methanogenesis. (Baker-FRC)
W82-01233

EUTROPHICATION,
Colorado Univ. at Boulder.
A. J. Medine, and D. B. Porcella.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 908-916, June, 1981. 119 Ref.

Descriptors: *Eutrophication, *Literature review, Phytoplankton, Macrophytes, Lakes, Nutrients, Model studies, Watershed protection.

Recent progress made in the field of eutrophication studies is summarized in this review article. Specific research was conducted concerning nutrient loading, effects of controlling nutrient loads, correlations and indicators. Effects of nutrient in-

crease were seen to be dependent upon the Vollenweider phosphorus loading relationship. The proper management and economic policies to arrest water quality deterioration or reverse undesirable trends were investigated. Regional surveys were conducted of various lake systems. Efforts in the area of eutrophication and ecosystem modeling have produced new data on the physical transport coupled with biological and chemical transformations. Phosphorus uptake rates of Cladophora growing near Harbor Beach, Michigan were modeled as a function of internal phosphorus levels. Long-term responses of Lake Ontario water quality parameters were simulated. Results of a holistic approach to ecosystem modeling were presented. Nutrient sources and sinks represent another area that saw increased research in recent years. The impacts of sediment, nitrogen, and phosphorus on aquatic biota were reviewed. The roles of phosphorus loading and dynamics in lake water were noted and related to agricultural impacts, loading functions, internal loading, epilimnetic recirculation, the role of organisms in the phosphorus cycle, and phytoplankton impacts. A linear programming model, designed for use in management decisions in a Pennsylvania 208 planning area, was used to analyze the impacts and economic aspects of conservation alternatives for controlling downstream dissolved and sediment associated phosphorus loads to lakes. Pollutant transport, the atmospheric loading of phosphorus, and a study of phosphorus release in 4-liter reaction vessels using lake sediments and distilled water were each investigated. Progress was also made in the areas of biological and chemical interactions and lake restoration. (Baker-FRC)
W82-01271

THE USE OF THE EQUILIBRIUM TEMPERATURE TO ESTABLISH THE HEAT BALANCE OF A WATER SURFACE (SUR L'UTILIZATION DE LA TEMPERATURE D'EQUILIBRE POUR L'ETABLISSEMENT DU BILAN THERMIQUE D'UN PLAN D'EAU),
Complexe Scientifique des Cezeaux, Aubiere (France). Lab. Associe de Meteorologie Physique.
C. Boutin, J. P. Albignat, and H. Isaka.
Hydrological Sciences Bulletin, Vol 26, No 2, p 159-170, June, 1981. 3 Fig, 3 Tab, 11 Ref. (English summary).

Descriptors: *Lakes, *Heat balance, *Equilibrium, Mathematical studies, Heat, Water temperature, Lake Godivelle, *France.

A series of daily heat balances was determined for La Godivelle lake in France, and daily estimates of the rate of heating of the lake were made using the methods developed by Edinger et al. (1968) and Keijman (1974) for equilibrium temperature. Using these methods, the exchange coefficient and the equilibrium temperature can be calculated to yield the best possible estimate of the rate of temperature increase. Also, data are used to describe the daily and seasonal behavior of the exchange coefficient and the equilibrium temperature for the summer and autumn stratification phases of the lake. (Small-FRC)
W82-01353

DATA ON THE STAGNANT PONDS OF THE SAVANNAH OF LAMTO (IVORY COAST) (DONNEES SUR LES MILIEUX LIMNIQUES STAGNANTS DES SAVANES DE LAMTO (COTE D'IVOIRE)),
Ecole Normale Superieure, Abidjan (Ivory Coast).
P. Forge.
Hydrobiologia, Vol 72, No 3, p 293-300, July, 1980. 9 Fig, 2 Tab, 15 Ref.

Descriptors: *Ephemeral lakes, *Aquatic life, *Stagnant water, Physicochemical properties, Lakes, Ponds, Species diversity, *Ivory Coast, Water quality, Vegetation, Savannah ponds, Savannah of Lamto.

The size variation through the season of the numerous temporary ponds in the savannah at Lamto, Ivory Coast, is explained by the theoretical water surplus, calculated as a function of temperature and rainfall. Five pond types were identified: ponds on burnt savannah, ponds on non-burnt savannah, forest ponds, and pools on rocks with high and low conductivity. Except for the high conductivity rock pools, the waters were slightly acid (pH 5.5-6.0), high in iron (1-5 ppm), and low in conductivity (30-80 micromho per cm). Four depth correlated vegetation zones were apparent. The savannah ponds had the most diverse fauna, whereas the forest and rock pools had limited numbers of life forms. (Cassar-FRC)
W82-01357

MINERAL IMPACT OF LAKES AS BACKGROUND FOR THEIR BIOGENIC DYNAMICS,
Max Planck Inst. fuer Limnologie zur Holstein (Germany, F.R.).
W. Ohle.
Hydrobiologia, Vol 72, No 1/2, p 51-59, July, 1980. 15 Fig, 4 Tab, 11 Ref.

Descriptors: *Primary production, *Turbidity, *Sedimentation, Lakes, Water quality, Algae, Phytoplankton, Minerals, *Light penetration, Secchi disks, Holstein area, Germany.

Two types of lakes were identified near Holstein, Germany. The Schohsee and Schluensee were enriched with clay, silt, sand and the hydroxides of Fe and Mn as a result of construction of an embankment and influx of wash water from a gravel pit, respectively. Grossner Ploner See and Pluss-See were not subject to mineral turbidity. During windy weather the mineral-impacted lakes were very turbid, but in clear weather, very clear. The Secchi disk readings were 4.6-6.0 meters for the mineral lakes and 2.5-3.8 meters for the other two. Epilimnic phosphates were low, 5-10 mg P per cu meter in the mineral lakes and 50-150 mg P per cu meter in the other lakes. The mean value of primary productivity in Schohsee was 0.33 g C per sq meters per day and in Pluss-See, 1.05 g C per sq meters per day. In Schohsee the carbon was reused 1.7 times before settling to the sediments; in Pluss-See, 15 times. The lakes receiving mineral matter, analogous to alpine lakes receiving turbid snowmelt waters, lost small phytoplankton cells and nutrients through adsorption on detritus and greater sedimentation rates. (Cassar-FRC)
W82-01359

PHYSICO-CHEMISTRY, DESTRATIFICATION AND NUTRIENT BUDGET OF A LOWLAND EUTROPHICATED MALAYSIAN RESERVOIR AND ITS LIMNOLOGICAL IMPLICATIONS,
Malaya Univ., Kuala Lumpur (Malaysia). Dept. of Zoology.
P. T. Arumugam, and J. I. Furtado.
Hydrobiologia, Vol 70, No 1/2, p 11-24, April, 1980. 6 Fig, 4 Tab, 28 Ref.

Descriptors: *Eutrophication, Destratification, *Nutrients, Phosphates, *Lakes, Water quality, Subang Lake, Buloh River, *Malaysia, Lake circulation, Stratification, Fishkills, Phytoplankton, Water pollution sources, Limnology, Reservoirs, Eutrophic lakes.

Extensive algal blooms and poor water quality prompted a limnological investigation of the eutrophied Subang Lake, Malaysia. Determination of the nutrient budgets showed that the reservoir is naturally oligotrophic, having very soft water with a low total dissolved iron concentration and extremely low levels of phosphate. The reservoir, similar to most Malaysian lakes, has a weak thermal stratification, an oxygenated euphotic zone, and a stable deoxygenated hypolimnion. This stratification provides for great species diversity and, at one station, vertical layering of plankton communities. The destratification that occurs on occasion results in sudden mass fish mortality and phytoplankton kills, algal blooms because of sudden liberation of nutrients from the hypolimnion, and poor taste and odor. (Cassar-FRC)
W82-01360

COMPARATIVE LIMNOLOGY OF NINE LAKES OF JAMMU AND KASHMIR HIMALAYAS,
Sri Pratap Coll., Srinagar (India). Hydrobiology Lab.
D. P. Zutshi, B. A. Subla, M. A. Khan, and A. Wanganeo.
Hydrobiologia, Vol 72, No 1/2, p 101-112, July, 1980. 4 Fig, 5 Tab, 33 Ref.

Descriptors: *Eutrophication, *Water quality, Water pollution effects, *Lakes, Himalayas, Physicochemical properties, *Limnology, Vegetation, Aquatic plants, Lake morphology, Kashmir, *India, Phytoplankton, Productivity, Algae, Comparison studies.

The physicochemical and biological features of nine lakes in the Kashmir Himalayas were studied. Two of the lakes are located in the lower Siwalik (altitude 604 meters), five in the Kashmir Valley (altitude 1584 meters), and two in the alpine region (above 2000 meters). The Siwalik lakes are subtropical, monomictic; the valley lakes are monomictic or develop unstable thermal stratification; and the alpine lakes are dimictic. The high altitude lakes have very low electrical conductivity, which increases with decreases in altitude. Most are of the medium hard water type. Ca and bicarbonate are most abundant. Cyanophycear dominate in eutrophic lakes, and diatoms and Chlorophyceae in less eutrophic lakes. Rotifers are the most common zooplankton. Macrophytes, present in 8 lakes, are not related to either altitude or physicochemical properties. One lake, Trigam, is classified as eutrophic, two lakes as meso-eutrophic and in rapid evolution, five as mesotrophic, and one as oligotrophic. Eutrophication is the result of increased human settlement in the drainage basins. (Cassar-FRC)
W82-01361

HYDROBIOLOGICAL STUDIES ON THE AJWA RESERVOIR, THE SOURCE OF RAW WATER SUPPLY TO THE BARODA WATER WORKS,
National Environmental Engineering Research Inst., Ahmedabad (India). Ahmedabad Field Centre.
I. Jayangoudar.
Hydrobiologia, Vol 72, No 1/2, p 113-123, July, 1980. 4 Tab, 22 Ref.

Descriptors: *Water quality, *Water supply, *Aquatic life, Lakes, *Reservoirs, *Ajwa Reservoir, *India, Physicochemical properties, Zooplankton, Phytoplankton, Photosynthesis, Productivity, Nutrients, Aquatic plants, *Hydrobiology.

Hydrobiological studies (April 1963 to December 1964) of the Ajwa Reservoir, India, raw water source for the Nimeta Water Works, Baroda, indicated that the surface layers are comparatively clearer and cleaner than the bottom layers from which raw water is presently being drawn for purification. No persistent thermal stratification was present. The pH was 8.1-8.7, i.e., 0.1-0.6 units lower in the bottom water than in the surface water. Total solids were maximum in June or July and minimum in August or September; water level and total solids were inversely correlated. Photosynthetic oxygen production varied considerably, 1.24-4.02 g per sq meter.per day in 1963 and 0.46-1.23 g per sq meter per day in 1964. Free ammonia, nitrates, nitrites, and phosphates were absent from surface and bottom waters. Silica levels were greater in bottom waters than in surface waters. Oxidizable organic matter (permanganate value) was higher in bottom water, 1.22-5.30 ppm, than in surface water, 0.78-1.92 ppm. Zooplankton were found in far larger numbers than the nutrient-limited phytoplankton. (Cassar-FRC)
W82-01364

BALANCE OF BIOGENIC ELEMENTS IN THE ARAL SEA UPON A DROP OF ITS LEVEL,
State Oceanographic Inst., Moscow (USSR).
V. N. Bortnik.
Water Resources (English Translation), Vol 7, No 5, p 457-462, September/October, 1980. 4 Tab, 17 Ref. Translated from Vodnye Resursy, No 5, p 140-147, September/October, 1980.

Descriptors: *Water, *Hydrologic budget, *Water level, *Aral Sea, Mathematical equations, Math-

ematical studies, Nitrogen, Phosphorus, Silicon, Aquatic productivity, Chemical analysis, Russia.

The Aral Sea is experiencing considerable changes in the balance of bigenic elements, significant salinization, and restructuring of its hydrobiological regime as a result of a drop in the level of the sea, a reduction of its area and volume, and substantial changes in the quality of river water entering the Sea. The main component of the income part of the balance of both dissolved and solid forms of biogenic elements is the biogenic content of the Amu Darya and Syr Darya rivers. During the period 1961 through 1977, the transport of the suspended load of the Syr Darya decreased in proportion to the decrease in its water discharge, while the suspended load discharge of the Amu Darya increased by about 1.5 times in spite of a considerable decrease in volume of water discharge. The average annual specific inflow of gross nitrogen with respect to the area and volume of the sea increased by about 33 percent between 1961 and 1977. The specific inflow of gross phosphorus increased by 33 to 36 percent, while that of dissolved silica decreased by about one-third. The average annual depositions of dissolved biogenic elements now exceed their total income with river runoff and precipitation. The balances of dissolved and solid biogenic elements in the Aral Sea are almost completely determined by its water balance. (Carroll-FRC)
W82-01370

DIURNAL, DEPTH-WISE, AND SEASONAL CHANGES OF PHYSICO-CHEMICAL FACTORS IN SATHIAR RESERVOIR,
Madurai Kamaraj Univ. (India). Dept. of Biological Sciences.
V. Kannan, and S. V. Job.
Hydrobiologia, Vol 70, No 1/2, p 103-117, April, 1980. 14 Fig, 48 Ref.

Descriptors: *Water quality, *Seasonal variation, *Diurnal distribution, Lakes, *Sathiar Reservoir, *India, Reservoirs, Eutrophic lakes, Eutrophication, *Physicochemical properties.

Physicochemical factors were studied diurnally, seasonally, and depth-wise in the highly eutrophic Sathiar Reservoir in the Sirumalai range, India, from April 1977 to March 1978. Water level fluctuated 2 to 6 meters, maximum being reached during the heavy monsoon season of August to November. Phytoplankton concentrations decreased with dilution and increased with lowered water levels. Transparency varied from 11.25 in April to July to 36.0 cm in winter. Transparency was governed not only by plankton density but also by solar radiation. Surface temperatures ranged from 26.4 degrees C in December to 32.4 degrees C in May. Maximum difference in temperature between surface and bottom was 5.5 degrees C. Dissolved oxygen at the surface varied between 15 mg per liter in the late afternoon to 4.82 mg per liter prior to sunrise and did not change with the season. There was a clinograde oxygen curve and an anoxic hypolimnion. Surface pH changed 0.22 to 0.9 units with photosynthetic activity. Redox potential at the surface coincided with oxygen and pH changes and decreased at night. Total phosphorus, nitrate and Kjeldahl nitrogen values indicate that the lake is eutrophic. (Cassar-FRC)
W82-01372

INVESTIGATIONS INTO THE OCCURRENCE OF MIDGE PLAGUES IN THE VICINITY OF HARDERWIJK (NETHERLANDS),
Limnological Inst., Oosterzee (Netherlands). Tjeukemeer Lab.
D. M. Beattie.
Hydrobiologica, Vol 80, No 2, p 147-159, May, 1981. 9 Fig, 6 Tab, 18 Ref.

Descriptors: *Midges, *Lakes, Eutrophication, Nuisance, Lighting, Insects, Aquatic insects, *Netherlands, Wolderwijd.

In response to complaints about midge swarms, a study was made of the total chironomid larval population in Wolderwijd, a large shallow Dutch lake, between February and October of 1977. The main species distribution pattern was of the same order of magnitude in both sand and stony substrates, based on substrate and total larval population size. Eutrophication did not cause extraordinarily large chironomid populations to produce excessive numbers of adult midges. The midge plagues experienced in the area are ascribed to the attraction of the midges for artificial light displayed by housing estates in the neighborhood of the lake. Unfavorable weather conditions occurring during 1977 prevented the normal development of larval populations in the lake during the summer, but the life cycle data indicate that in most years, one or more summer generations will occur with population sizes similar to that recorded for the overwintering generations. This would increase the number of occasions on which midges would be present during the summer, but not increase the number of midges on any one occasion. It was concluded that the number and frequency of midges emerging from Wolderwijd are not extraordinarily high for a shallow, temperate-zone lake of it's size. Midge larval eradication programs could upset the lake ecosystem balance. Selective light attraction and killing of adults might reduce the nuisance. (Baker-FRC)
W82-01378

THE CRUSTACEAN ZOOPLANKTON OF MALI (WEST AFRICA),
Ghent Rijksuniversiteit (Belgium). Zoology Inst.
H. J. Dumont, J. Pensaert, and I. Van de Velde.
Hydrobiologia, Vol 80, No 2, p 161-187, May, 1981. 14 Fig, 2 Tab, 55 Ref.

Descriptors: *Lakes, *Zooplankton, *Chemical composition, Chemical properties, Minerals, *West Africa, *Mali, Crustaceans, Aquatic life.

A study of the zooplankton of aquatic biotopes in Mali revealed 48 species of Phyllopoda, 24 species of Copepoda, and a freshwater shrimp. A total biogeographical discussion is not possible at this point, since, for many species, both taxonomical position and chronological records are fragmentary and uncertain. At least 29 species, however, seem to be restricted to Africa, and some even to West Africa. The water chemistry of the lakes is characterized by a low mineral content, but seems not to be distributive to any of the numerous zooplankton species encountered. The zooplankton communities are typically composed of numerous species. The Niger delta appears to be part of the biological boundary of the Sahara as far as aquatic invertebrates are concerned. West African equatorial climate endemics and arid to semi-arid endemics meet and interpenetrate each other's ranges over short distances. (Baker-FRC)
W82-01379

PHYSICAL AND CHEMICAL STUDIES OF LAGO TUPE; A CENTRAL AMAZONIAN BLACK WATER 'RIA LAKE',
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
H. Rai, and G. Hill.
Internationale Revue der Gesamten Hydrobiologie, Vol 66, No 1, p 37-82, 1981. 34 Fig, 5 Tab, 85 Ref.

Descriptors: *Dystrophic lakes, *Physicochemical properties, Lakes, Oligotrophic lakes, *Limnology, Lake morphology, Alkalinity, Acidity, Thermal stratification, Seasonal variation, Suspended solids, Dissolved oxygen, Oxygen, Minerals, Iron, Phosphates, Nutrients, *Brazil, Lago Tupe.

All depths of the Lago Tupe, a Central Amazonian dystrophic black water, were studied for a period of one year to determine the physical and chemical properties of the lake. Thermal properties, suspended matter and dissolved solids were studied, in addition to ionic composition, alkalinity, hardness, pH and dissolved oxygen. The lake was formed in the pleistocene era; it has a surface area of 48 ha and a length of 3 km. Temperatures in this oligomictic lake varied only 0.7 degrees C at all depths for the year, but thermal stratification was exhibited. Suspended solids and salinity were low. Lago Tupe is a sodium sulfatochloride water type and showed a striking anion excess, presumably created as a result of organometal formation. All cations increased at low lake levels. According to iron levels, the lake was put into Yoshimura's category. Low alkalinity and hardness complete the profile of a system poor in minerals. The pH varied from 4.4 in wet weather to 5.8 in drier times and demonstrated a uniform vertical distribution. Dissolved oxygen was in general about 6 mg/liter but occasionally reached 11.4 mg/liter, showing a clinograde profile. Phosphates averaged 11.6 micrograms/liter and were of major importance to primary and bacterial production. Nitrate nitrogen averaged 21.68 micrograms/liter, and no evidence of nitrification was noted. Ammonia was seen as the major contributor to the nitrogen pool. Silica averaged 2.4 mg/liter and did not appear to be a distinguishing characteristic of this tropical system. Physical and chemical attributes of Lago Tupe can be viewed as an extension of and a complement to the river system of which it is an integral part. (Baker-FRC)
W82-01381

THE EFFECT OF FERTILIZATION WITH PHOSPHORUS AND NITROGEN VERSUS PHOSPHORUS ALONE ON EUTROPHICATION OF EXPERIMENTAL LAKES,
Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5C.
W82-01457

COMPARISON OF FIRST-ORDER ERROR ANALYSIS AND MONTE CARLO SIMULATION IN TIME-DEPENDENT LAKE EUTROPHICATION MODELS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
D. Scavia, W. F. Powers, R. P. Canale, and J. L. Moody.
Water Resources Research, Vol 17, No 4, p 1051-1059, August, 1981. 7 Fig, 1 Tab, 36 Ref.

Descriptors: *Error analysis, *Monte Carlo method, *Model studies, *Lakes, *Eutrophication, Saginaw Bay, Lake Huron, Algae, Nutrients, Phosphorus, Nitrogen, Zooplankton, Phytoplankton, Variation coefficient, Simulation analysis, Comparison studies.

Two methods for estimating variance associated with eutrophication model output were examined: Monte Carlo simulation and first-order variance propagation. The lake eutrophication model used for study simulated dynamics of phytoplankton, herbivorous and carnivorous zooplankton, three nitrogen forms, and two phosphorus forms. It was applied in this case to Saginaw Bay, Lake Huron. Results of analysis showed that the two methods had some differences. Monte Carlo means were most like the measurements, but Monte Carlo medians were most like the deterministic model output. The two methods agreed most closely on both state variable values and their variances when Monte Carlo output distributions were symmetric. Under these conditions, both estimates were measures of variance associated with total populations (such as total algae). Distributions changed dramatically with time for most state variables. For asymmetric distributions first-order variance estimates measured variability about the typical component of the total population (such as a particular species) and Monte Carlo variance estimates measured variability of the population mean, which is usually of more interest. The Monte Carlo analysis requires along computations in both long-term predictions and examination of relative error sources in complex models. (Cassar-FRC)
W82-01460

APPLICATION OF NUTRIENT-SATURATED GROWTH MODEL TO PHYTOPLANKTON MANAGEMENT IN FRESHWATER PRAWN (MACROBRACHIUM ROSENBERGII) PONDS IN HAWAII,
Hawaii Univ., Honolulu. Dept. of Oceanography.
E. A. Laws, and S. R. Malecha.
Aquaculture, Vol 24, No 1/2, p 91-101, May, 1981. 4 Fig, 1 Tab, 17 Ref.

Descriptors: *Aquaculture, *Nutrients, *Model studies, Phytoplankton, Ponds, Oxygen, Aquatic plants, *Hawaii.

A model of nutrient-saturated growth of Chlorella with significant modification in only two of nine parameters was found to provide an excellent description of experimental data collected from six large experimental tanks and one earthen production pond. The results suggest that in order to maintain system stability with respect to oxygen fluctuations, primary production rates in other commercial ponds are usually kept well below levels that could be obtained under optimal conditions. Application of the model to field data shows that phytoplankton populations in prawn ponds should be kept between 150 and 400 mg/cubic meter chlorophyll a (Chl a) in order to prevent anoxia in worst case situations such as calm nights. Due to a negative correlation between light-limited growth rates and Chl a concentrations, little increase in photosynthesis occurs if Chl a concentrations are raised above 2 g/cubic meter, and there is a negative correlation between photosynthesis and Chl a concentrations for Chl a values greater than 5 g/cubic meter. Therefore even under ideal conditions 1 meter deep ponds should probably be operated with Chl a concentrations less than 2 g/cubic meters. The success of the light limited model in describing data from both monospecific continuous culture systems and diverse populations in prawn ponds suggests that the model may have wide applicability in algal mass culture systems. (Baker-FRC)
W82-01483

NEPHELOID AND SUSPENDED PARTICULATE MATTER IN SOUTH-EASTERN LAKE MICHIGAN,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
R. L. Chambers, and B. J. Eadie.
Sedimentology, Vol 28, No 3, p 439-447, June, 1981. 7 Fig, 24 Ref.

Descriptors: *Sediment distribution, *Suspended sediments, *Nepheloid layer, Lakes, *Lake Michigan, Great Lakes, Lake sediments, Sediments, Particulate matter, Thermocline, Thermal stratification, Stratification.

A benthic nepheloid layer observed in southeastern Lake Michigan was studied during April 1977 to October 1979. This layer, with high total suspended matter and high total particulate surface area, started to develop in late April and formed a distinct benthic zone by mid May. At 1 meter from the bottom, the concentrations of total suspended matter increased by 2-20 times compared with the hypolimnion. Greatest increases were observed at the shelf-slope boundary, which is also the approximate mean depth of the thermocline. Thickness of the layer varied from a few meters at the shelf-slope boundary to greater than 10 meters at the base of the slope. The particulate flux increased exponentially from 10 meters above the bottom to 1 meter above the bottom, suggesting that a large fraction of the collected material came from resuspension. It is hypothesized that currents generated during the thermal bar period resuspend the winter accumulation of surficial shelf sediments, transport it lakeward, and create the nepheloid layer. (Cassar-FRC)
W82-01499

RELEASE OF PHOSPHORUS BY CERTAIN BENTHIC INVERTEBRATES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
W. S. Gardner, T. F. Nalepa, M. A. Quigley, and J. M. Malcyzk.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 38, No 8, p 978-981, August, 1981. 1 Tab, 25 Ref.

Descriptors: *Invertebrates, *Phosphorus, *Nutrient release, *Lake Michigan, Lakes, Metabolism, Macroinvertebrates, Benthic fauna, Aquatic animals, Midges, Oligochaetes, Tubificids, Stylodrilus, Phosphates, Excretion, Sediments.

Three benthic invertebrates from Lake Michigan (Stylodrilus heringianus, tubificids, and Chironomus spp.) were incubated in wet sand at 5 and 20 C for 24 hours with full and empty digestive systems to determine phosphate release rates. Results suggest that phosphate excretion could account for virtually all of the P released from aerobic sediments and must be considered an important mechanism for nutrient release into the lake. Mean weight-specific inorganic phosphate release rates ranged from 0.1 to 0.8 nmol P per mg ash free dry weight per hour. Chironomids release rates (0.27-0.81 nmol P per mg per hour) were significantly greater than rates for oligochaetes (0.12-0.27 nmol P per mg per hour). There were no significant differences in inorganic P release rates from animals with full or empty guts, with the exception of S. heringianus in the 24 hour study. Short-term experiments (30 min) showed much higher values (3.34 + or - 1.78 nmol inorganic P per mg per hour and 3.59 + or - 4.06 nmol organic P per mg per hour). Temperature effects on release rates were not as great as expected, and definitive conclusions were not possible. (Cassar-FRC)
W82-01502

THE EFFECT OF CHANGING SEDIMENT SUPPLY ON SEDIMENTATION IN A GLACIER-FED LAKE,
Illinois Univ. at Chicago Circle, Chicago. Dept. of Geological Sciences.
N. D. Smith.
Arctic and Alpine Research, Vol 13, No 1, p 75-82, February, 1981. 5 Fig, 18 Ref.

Descriptors: *Lake sediments, *Glacial sediments, *Sediment distribution, Glacial lakes, Sedimentation rates, *Canada, *Bow Lake, Alpine regions, Glacial streams.

Bow Lake, located in Alberta, Canada, has been studied as part of an investigation of sedimentation in glacier-fed intermontane lakes. This deep, thermally stratified alpine lake is fed by an overland meltwater stream from Bow Glacier, which has been generally receding from its Neoglacial maximum. The sedimentation regime of the lake was abruptly changed when a pond, acting as a sediment trap, developed at the margin of the receding glacier in 1955. Prior to this development, underflows which formed thick varves in the lower areas of the lake floor dominated sedimentation in Bow Lake. The reduction in sediment input caused the dominant mechanism of sediment dispersal to change from underflows to interflows. The inflows are now dispersed through rightward-deflected interflows moving above the hypolimnion and unaffected by bottom topography. The sediment-trapping capabilities of temporary marginal ponds and the effects which they trigger should be considered as potentially important means of creating variations in the lateral and vertical dispositions of glaciolacustrine sediments. (Carroll-FRC)
W82-01510

HISTORICAL CHANGES AND RELATIONSHIP TO INTERNAL LOADING OF SEDIMENT PHOSPHORUS FORMS IN HYPERTROPHIC PRAIRIE LAKES,
National Water Research Institute, Winnipeg (Manitoba). Freshwater Inst.
R. J. Allan, J. D. H. Williams, S. R. Joshi, and W. F. Warwick.
Journal of Environmental Quality, Vol 9, No 2, p 199-206, April/June, 1980. 4 Fig, 3 Tab, 17 Ref.

Descriptors: *Eutrophication, *Phosphorus, *Water pollution effects, *Lake sediments, Bottom sediments, Nutrients, Lake beds, Lake classification, Eutrophic lakes, Trophic level, Core logging, Geologic time, Canada.

A study was conducted on five Canadian mainstream lakes and two sloughs to see of historical changes in phosphorus form concentrations in sediment cores would provide clues to presettlement trophic state and to elucidate the role of sediment in internal nutrient loading of hypertrophic lakes. Nonapatite phosphorus levels in sediment cores showed that most Prairie water bodies were eutrophic prior to European settlement and extensive farming in the area. Urban and agricultural effluents have caused increased levels of nonapatite phosphorus in surface sediments. Organic phosphorus increases in surface sediments are attributed to post-settlement increases in lake productivity. Increases in nonapatite inorganic phosphorus in surface sediments reflect urban and/or agricultural effluents modified by upward migration and pooling. Internal loading is evidenced by declines in surface sediment nonapatite inorganic phosphorus. (Geiger-FRC)
W82-01516

ZOOPLANKTON ABUNDANCE AND DIVERSITY IN CENTRAL FLORIDA GRASS CARP PONDS,
Central Florida Univ., Orlando. Dept. of Biological Sciences.
D. L. Fry, and J. A. Osborne.
Hydrobiologia, Vol 68, No 2, p 145-155, January, 1980. 7 Fig, 6 Tab, 48 Ref.

Descriptors: *Zooplankton, *Carp, Fish, *Temporal distribution, Plankton, Distribution, Rotifers, Aquatic animals, *Ponds, *Comparison studies, Florida.

Three adjacent ponds were constructed and filled during June of 1975 at the University of Central Florida. The depth ranged from surface to 1.5 meters. Water level was maintained throughout the study by weekly filling. Nine species of rooted aquatic plants were planted in pure stands in the ponds prior to filling. In November, 9 grass carp were stocked in pond 1 and 85 grass carp were stocked into pond 2. In December the ponds were drained, and the weights, lengths, and body condition of the grass carp were determined. Grass carp did not affect the quality of the water, and they also had little direct or indirect effect on the zooplankton in the ponds. The abundance and species diversity of zooplankton were not significantly different between ponds prior to grass carp stocking. What variation in species between the ponds did exist was more likely due to temporal variation rather than to the grass carp. The number of zooplankton species was highest during the fall in pond 1, and during the summer in ponds 2 and 3. Rotifer species were in the main responsible for the seasonal variation in zooplankton species numbers. The monthly mean number of species prior to grass carp was near 10 in pond 1, elevating to 12 for pond 3. After the grass carp were placed into the ponds, the monthly mean number of species was 9 for pond 1, and more than 12 for ponds 2 and 3. Measurements of orthophosphate, nitrite nitrogen, and nitrate nitrogen changed little throughout the study. (Baker-FRC)
W82-01520

THE EFFECTS OF A NEW RESERVOIR ON THE ATTACHED DIATOM COMMUNITIES IN HUNTINGTON CREEK, UTAH, U.S.A.,
Brigham Young Univ., Provo, UT. Dept. of Botany and Range Science.
L. E. Ross, and S. R. Rushforth.
Hydrobiologia, Vol 68, No 2, p 157-165, January, 1980. 3 Fig, 4 Tab, 14 Ref.

Descriptors: *Diatoms, *Population dynamics, *Reservoirs, Dams, Population density, Populations, *Powerplants, *Ecological effects, Dam construction, Huntington Creek, *Utah.

The effects of a new power plant and reservoir were examined on the structure of the attached diatom communities of Huntington Creek, Utah. Construction of the coal-fired generating plant and Electric Lake Dam was begun in 1970. One sampling site was located about 14 km below the main diversion dam on Huntington Creek. Three additional sites were established below the generating plant. A fifth site is 5 km above the North Huntington Reservoir diversion dam, near the Utah Power and Light Company. Two additional sites are at two campgrounds, while the 8th site is at the junction of the Left and Right Forks of Huntington Creek and the ninth site is 2.2 km below Stuart Fire Station at an elevation of 2250 meters. One hundred diatom taxa were identified during the study. No seasonal patterns could be identified

from the resulting phenogram, and no significant differences were seen between the 1971-72 and 1976-77 collections, before and after the completion of the power plant. Diatom communities near the dam were apparently not significantly affected by construction of the reservoir. The two most prevalent species were Achnanthes minutissima and Navicula radiosa var. tenella. These two species were collected at all nine sites, and generally were abundant throughout all collection periods. It was concluded from various statistical analyses that the reservoir had not greatly affected net-plankton and nannoplankton assemblages in the stream. (Baker-FRC)
W82-01521

COLLAPSING APHANIZOMENON FLOS-AQUAE BLOOMS: POSSIBLE CONTRIBUTIONS OF PHOTO-OXIDATION, O2 TOXICITY, AND CYANOPHAGES,
Manitoba Univ., Winnipeg. Dept. of Botany.
A. M. Coulombe, and G. G. C. Robinson.
Canadian Journal of Botany, Vol 59, No 7, p 1277-1284, July, 1981. 3 Fig, 1 Tab, 29 Ref.

Descriptors: *Algae, *Toxicity, Cyanophyta, *Eutrophication, Lakes, Eutrophic lakes, Pathogens, Viruses, *Oxidation.

Four bloom collapses of Aphanizomenon flos-aquae in three shallow eutrophic pothole lakes in southwest Manitoba were examined; for the triggering mechanism. The environmental conditions before and during the blooms were not the same for each event. Therefore, a single triggering mechanism could not be cited as a cause. Three of the bloom collapses (two in mid-July 1979, one in mid-August 1979) began when the lakes were thermally stable and conditions were favorable for death from photo-oxidation and/or oxygen toxicity. The fourth, in mid-August 1973, began during a period of lake thermal instability, ruling out photo-oxidation and oxygen toxicity as the triggering mechanism in this case. Virus like particles were detected by electron mircoscopy in cells from three of the blooms (cells from the fourth could not be examined). They were polyhedral and 50-60 micrometers in diameter. Since transmission and isolation of these viruslike particles has not been proved, it cannot be stated that they triggered collapse by viral infection. Cyanophage-induced algal lysis, perhaps caused by thermal instability, may have been a factor in the algal population decline. Other contributing factors not tested in this study are bacterial and fungal pathogens of algae, autolysis, and senescence. (Cassar-FRC)
W82-01595

2I. Water In Plants

CANOPY TEMPERATURE AS A CROP WATER STRESS INDICATOR,
Science and Education Administration, Phoenix, AZ. Water Conservation Lab.
R. D. Jackson, S. B. Idso, R. J. Reginato, and P. J. Pinter, Jr.
Water Resources Research, Vol 17, No 4, p 1133-1138, August, 1981. 6 Fig, 1 Tab, 22 Ref.

Descriptors: *Water stress, *Canopy, *Temperature, Evapotranspiration, Crop water stress index, Wheat, Irrigation requirements, Soil moisture, Agriculture.

A crop water stress index (CWSI) may be useful for quantitative determination of crop water stress. The CWSI is readily calculated by hand calculator or computer from canopy temperature (measured with an infrared thermometer), wet- and dry-bulb air temperature, and estimated net radiation. The index can be used in place of the stress-degree-day in situations where vapor pressure deficit data are available. The relationship can be expressed as: CWSI = 1 - E/E sub p, where E and E sub p are the actual and potential evapotranspiration. In four experimental wheat plots subjected to different degrees of water stress, pertinent variables were measured. The calculated CWSI, plotted as a function of time, closely paralleled a plot of the extractable soil water in the 0 to 1.1 meter zone. Errors may result from excess wind (increases CWSI), rapidly changing cloud conditions, inaccurate wet- and dry-bulb readings, inadequate calibration of the infrared thermometer, or including some of the soil background in the infrared reading. The CWSI may be useful as an irrigation guide for grains and alfalfa, but probably not for potatoes. (Cassar-FRC)
W82-01106

EFFECT OF WATER, NITROGEN AND ROW SPACING ON THE YIELD AND OIL CONTENT OF SAFFLOWER,
Central Arid Zone Research Inst., Jodhpur (India).
S. D. Singh, and M. Yusuf.
Indian Journal of Agricultural Sciences, Vol 51, No 1, p 38-43, January, 1981. 3 Fig, 1 Tab, 7 Ref.

Descriptors: *Crop yield, *Moisture availability, Nitrogen, Farm management, Moisture stress, Soil moisture, Safflower oil, *Safflower, Water use efficiency.

The quantitative relationship of water, nitrogen, and row spacing to yield and oil content of safflower was investigated. Field experiments were conducted using 'A 300' safflower during 1972-75. The site was in an arid climate, with an average period of bright sun for 9-10 hr, and an average daily maximum temperature of 26 degrees C during winter and 36 degrees C during March-April. Low humidity, light wind, and high open water evaporation were characteristic of the area. The soil was a coarse loam with a pH of 7.5. No contribution was made of water to the crop by rain or upward movement from lower soil depths. The yield response of safflower to N was quadratic under adequate (51 cm), negligible, and restricted (8 cm) supplies of moisture. Narrow row spacing (20 cm) required less water and N to produce optimum crop yields than did wider row spacings of 60 cm. The oil content had a quadratic relation with moisture supply but was independent of spacing. Its relationship was inverse with N levels when water supply was restricted, and direct when it was adequate. Narrow row spacing, optimum water supply of 29 cm, and adequate N of 80 kg/ha were needed to obtain optimum oil yields. (Baker-FRC)
W82-01112

COMPARISON OF TESTS CHARACTERIZING VARIETIES OF BARLEY AND WHEAT FOR MOISTURE STRESS RESISTANCE,
Department of Agriculture, Charlottetown (Prince Edward Island). Research Station.
H. G. Nass, and J. D. E. Sterling.
Canadian Journal of Plant Science, Vol 61, No 2, p 283-292, April, 1981. 5 Tab, 24 Ref.

Descriptors: *Crops, *Moisture stress, Soil moisture, Soil moisture retention, Available water, Moisture availability, Testing procedures, Barley, Wheat.

A number of simple tests were evaluated for moisture stress tolerance and avoidance in characterizing cereal cultivars. Eight cultivars of wheat and seven cultivars of barley were evaluated. Of the avoidance tests, visual wilting correlated well with tiller survival, but the water loss from leaves and stomatal diffusion resistance tests did not. Of the tolerance tests, root weight under moisture stress showed a good relationship with survival. Root weight without moisture stress correlated well with survival for wheat and somewhat less for barley. A comparison of root and leaf weight in two soils differing in moisture-holding ability was useful but less correlated with survival. An unsatisfactory tolerance test was that of germination in mannitol, as there was no correlation in rankings with drought survival. Two semi-dwarf wheat cultivars, Pitic and Fielder, and the two-rowed barley cultivars Nordal and Volla demonstrated the greatest moisture stress resistance. This study of avoidance and tolerance tests leads to the conclusion that no one test used alone has sufficient reliability to determine overall cultivar drought response in wheat and barley. At least one test measuring avoidance and one measuring tolerance should be used. (Baker-FRC)
W82-01114

CLIMATIC FACTORS CONTRIBUTING TO YEAR-TO-YEAR VARIATION IN GRAIN YIELD OF CORN ON BROOKSTON CLAY,
Department of Agriculture, Harrow (Ontario). Research Station.
V. A. Dirks, and E. F. Bolton.
Canadian Journal of Plant Science, Vol 61, No 2, p 293-305, April, 1981. 4 Fig, 11 Tab, 19 Ref.

Descriptors: *Crop yield, *Seasonal variations, Prediction, Moisture availability, Clays, Soil types, Farming, Farm management, *Corn, Climatology, Brookston clay, *Ontario.

Some climatic components contributing to the year-to-year variation in a 13 year rotation experiment involving corn grown on Brookston clay are reported. Brookston clay is an orthic humic gleysol. The results are interpreted in regard to their significance for corn production in southwestern Ontario and for the possible development of predictive models for yield. Four climatic vectors accounted for as much as 80% of the total year variance of grain yield. These four factors were moisture deficit days, available moisture, corn heat units, and an effect allowing for the special weighting of these factors during the critical tasselling-silking period. The nature of the response of corn yield to these climatic vectors depended on the level of N supplied via fertilizer, soil condition, and fertility as maintained by rotation. Prediction of yield using weather data and water budget to estimate moisture deficit days for the soil type appears feasible where corn is fertilized, and can be done by the 15th of August, which is about 6 weeks before the corn is mature. The need for basing area predictions on soil type and farm management practices is discussed. (Baker-FRC)
W82-01115

THE EFFECT OF SNOW TRAPPING AND CROPPING SEQUENCE ON MOISTURE CONSERVATION AND UTILIZATION IN WEST-CENTRAL SASKATCHEWAN,
Department of Agriculture, Swift Current (Saskatchewan). Experimental Farm.
For primary bibliographic entry see Field 3F.
W82-01117

YIELD AND PHENOTYPIC TRAITS OF SEMIDWARF AND NORMAL-STATURED BARLEY (HORDEUM VULGARE L.) GENOTYPES GROWN UNDER DIFFERING LEVELS OF MOISTURE STRESS,
Department of Agriculture, Swift Current (Saskatchewan). Research Station.
R. B. Irvine, B. L. Harvey, and B. G. Rossnagel.
Canadian Journal of Plant Science, Vol 60, No 2, p 733-736, April, 1980. 3 Tab, 10 Ref.

Descriptors: *Crop yield, *Moisture stress, Soil moisture, Barley, Moisture availability, Comparison studies.

Several environments were used to grow semidwarf and normal-statured barley genotypes. These environments differed mainly in the levels of plant available soil moisture. Grain yields differed significantly due to environment and genotype, and there was a nonsignificant tendency for semidwarf genotypes to yield less, relative to their tall counterparts, when grown in environments with restricted moisture supply. The stature of the genotype did not appear to influence the expression of yield components, harvest index or flag leaf area. This study indicates that plant stature is not consistently associated with the magnitude of any yield component, so selection procedures followed in normal-statured barleys should be effective in semidwarf populations. (Baker-FRC)
W82-01121

A PARAMETRIC CROP WATER USE MODEL,
California Univ., Los Angeles. Dept. of Geography.
J. E. Burt, J. T. Hayes, P. A. O'Rourke, W. H. Terjung, and P. E. Todhunter.
Water Resources Research, Vol 17, No 4, p 1095-1108, August, 1981. 10 Fig, 4 Tab, 80 Ref.

Descriptors: *Parametric hydrology, *Agricultural hydrology, *Water requirements, Model studies, Mathematical models, Computer models, Water consumption, Evapotranspiration, Crop production, Droughts, Soil-water-plant relationships.

Agricultural water consumption, both temporal and spatial, can be predicted with a model, WATER, which is a compromise between area-specific, data-based regression models and expensive, complex energy-mass exchange models. Among the crops for which fluctuating water demand can be simulated are wheat, corn, rye, barley, rice, potatoes, and alfalfa. Model validation was accomplished by comparison of calculated results with lysimeter data at four grain corn-growing locations in the Western states during the 1974 growing season. The model is useful in predicting the effects of droughts and other weather variables on crop water requirements. Usable in any region, it can also identify areas of optimum or marginal water conditions, adjust choice of crops to the available water, and simulate interactions of climate and plant growth to reduce the necessity for field studies. (Cassar-FRC)
W82-01310

DROUGHT SUSCEPTIBILITY OF TWO TOMATO (LYCOPERSICUM ESCULENTUM) VARIETIES,
Ibadan Univ. (Nigeria). Dept. of Agronomy.
O. Babalola, and M. O. A. Fawusi.
Plant and Soil, Vol 55, No 2, p 205-214, 1980. 4 Fig, 2 Tab, 16 Ref.

Descriptors: *Moisture stress, *Crop yield, *Tomatoes, Soil moisture, Drought, Moisture availability, *Soil-water-plant relationships.

Some effects of identical moisture stress levels were measured under field conditions on two tomato varieties. Drought susceptibility of these cultivars was measured under soil moisture conditions in greenhouse experiments. Plant height, root length, number of flowers and total dry matter production were significantly affected by soil water potential treatments. Only root length and total dry matter production were significantly different between cultivars. Fruit yield was significantly affected by soil water potential treatments and the interaction between variety and moisture. Generally the drought susceptibility factor increased with decreasing soil water potential. Findings suggest that the stomata of Fireball remained partially closed under conditions of stress in order to reduce vapor losses, thereby accounting for the higher yields under stress conditions. The slightly deeper rooting system for the Fireball variety is also a definite advantage under stress conditions, as the exploitation of the subsoil is facilitated when the soil surface dries out. (Baker-FRC)
W82-01369

HYDRAULIC CONDUCTIVITY OF FOUR COMMERCIAL CITRUS ROOTSTOCKS,
Agricultural Research and Education Center, Lake Alfred, FL.
J. P. Syvertsen.
Journal of the American Society for Horticultural Science, Vol 106, No 3, p 378-381, May, 1981. 2 Fig, 1 Tab, 21 Ref.

Descriptors: *Citrus fruits, *Permeability coefficient, Conductivity, Roots, Drought resistance, *Hydraulic conducting.

The growth characteristics and hydraulic conductivity of intact root systems of four citrus rootstocks commonly used in Florida were investigated. The plants used were 6- and 12-month old greenhouse grown seedlings of RL, sour orange (SO), Carrizo citange (Car), and Cleopatra mandarin (Cleo). Six-month old RL seedlings had the largest leaf area, while Car had the smallest. There was no difference among the root dry weights. The hydraulic conductivity of roots of 6-month old RL seedlings was significantly greater than that of SO and Cleo seedlings. Conductivities of Car were intermediate and not significantly different from either RL or SO and Cleo. Carrizo had the highest conductivity of the 12-month old seedlings, however. Rough lemon seedlings had conductivities that were significantly less than those of Car, but greater than conductivities of SO and Cleo. SO and Cleo had similar root conductivities. The hydraulic conductivity of roots of all four rootstocks increased linearly with temperatures between 15 and 30 degrees C. The slope of root conductivity vs. temperature associated with the Cleo data is significantly less than that of the other rootstocks. It is possible that differences in hydraulic conductivity of roots could result from differences in root extension or suberization as a result of differences in soil, water stress, or other environmental conditions. The relatively high root growth rate and hydraulic conductivity of RL can be used to explain its greater efficiency of soil water extraction and its ability to produce larger trees than many other citrus rootstocks. Drought resistance may also be partly explained by the hydraulic conductivity of the roots. (Baker-FRC)
W82-01546

2J. Erosion and Sedimentation

TRANSPORTS IN THE DULUTH-SUPERIOR HARBOR,
Minnesota Univ.-Duluth. Dept. of Physics.
For primary bibliographic entry see Field 5B.
W82-01136

WAVE CLIMATE AND POTENTIAL LONGSHORE SEDIMENT TRANSPORT PATTERNS, NOTTAWASAGA BAY, ONTARIO,
Guelph Univ. (Ontario). Dept. of Geography.
R. G. D. Davidson-Arnott, and W. H. Pollard.
Journal of Great Lakes Research, Vol 6, No 1, p 54-67, 1980. 9 Fig, 4 Tab, 30 Ref.

Descriptors: *Sediment transport, *Waves, *Shores, Model studies, Littoral drift, Lake shores, Lakes, Lake Ontario, *Nottawasaga Bay, Beach erosion, Wasaga Spit, Computer models, Sediment deposition, Erosion, Ontario.

A storm wave climate was hindcast for Nottawasaga Bay, Ontario, using wind records at Cove Island for 1966-70 and the Sverdrup-Munk-Bretschneider technique. This information is necessary for predicting the effects of human activities such as dredging, shore development, and oil spills on the lake coastal zone. A computer model of wave refraction within the bay incorporates 13 wave classes, defined on the basis of significant wave height, period, and direction. The total and the longshore component of wave energy flux are determined for each wave class. The total annual energy flux and net longshore component are determined for 55 points spaced at 1 km intervals by multiplying the value of energy flux at each point by the mean annual frequency for that wave class and summing the values for all relevant waves. A simple model of potential erosion, transport, and desposition patterns within the bay is developed from the variation in net longshore component values. Model predictions are compared with sediment transport patterns visible in aerial photographs and with measurements of erosion and accretion at selected points. It is concluded that deposition of sediment from the Nottawasaga River, not littoral transport, causes the eastward growth of Wasaga Spit. (Cassar-FRC)
W82-01156

A VERIFICATION STUDY ON A RESERVOIR SEDIMENT DEPOSITION MODEL,
Kentucky Univ., Lexington. Dept. of Agricultural Engineering.
A. D. Ward, D. L. Rausch, C. T. Haan, and H. G. Heinemann.
Transactions of the ASAE, Vol 24, No 2, p 340-352, March/April, 1981. 8 Fig, 3 Tab, 16 Ref.

Descriptors: *Sediment deposition. *Reservoir silting, Hydrographs, DEPOSITS model, Model studies, Mathematical models, *Agricultural reservoirs, Missouri.

Seven years' data from monitoring two agricultural reservoirs in Missouri were used to verify the DEPOSITS model, a conceptual design model for predicting the sediment trapping performance of small impoundments. Both the model and its sedimentgraph default option gave good estimates of the reservoirs' performance during the 13 storm events in this study. The EPA overflow rate method gave poorer results. (Cassar-FRC)
W82-01176

AQUATIC SEDIMENTS,
Clarkson Coll. of Technology, Potsdam, NY.
For primary bibliographic entry see Field 5B.
W82-01279

CHANNEL INSTABILITY IN A BRAIDED, SAND BED RIVER,
Arizona State Univ., Tempe. Dept. of Geography.
W. L. Graf.
Water Resources Research, Vol 17, No 4, p 1087-1094, August, 1981. 5 Fig, 3 Tab, 26 Ref.

Descriptors: *Braided rivers, *Probabilistic process, *Channel morphology, Rivers, Aggrading rivers, Alluvial rivers, *Gila River, *Arizona, Unstable channels, Alluvial channels, Prediction, *Sedimentation, Sediment transport, Erosion.

Probabilistic approaches are a reliable guide to future behavior of braided, sand bed rivers in alluvial valleys, if no large scale interruptions interfere (large dam or bridge construction, wholesale phreatophyte changes, extensive sand and gravel mining, or radical climate change). The Gila River, Arizona, representative of this type of river, does not meet assumptions of equilibrium. Analysis of maps and photographs dating back to 1868 produced at intervals over this 112-year period reveals a pattern of instability and destructive channel migration. Zones of stability and hazardous instability alternate at about 3.2 km intervals. The sinuosity of the main channel has been close to 1.18 through the past century, although actual location of the flow has varied. Instability zones correspond with the surface of the sediment wedge behind the dam and areas of dense phreatophyte growth; stable zones, with areas controlled by bedrock, man made structures, and the requirement to maintain consistent sinuosity. (Cassar-FRC)
W82-01316

SITES OF RIVER-DERIVED SEDIMENTATION IN THE OCEAN,
Delaware Univ., Newark. Coll. of Marine Studies.
For primary bibliographic entry see Field 7B.
W82-01332

GEOMORPHOLOGY OF THE COLORADO RIVER IN THE GRAND CANYON,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
A. Howard, and R. Dolan.
Journal of Geology, Vol 89, No 3, p 269-299, May, 1981. 12 Fig, 6 Tab, 40 Ref.

Descriptors: *Geomorphology, *Sedimentation, Rivers, Alluvial deposits, Fluvial sediments, Floods, Dams, Canyons, *Colorado River, *Grand Canyon, Glen Canyon Dam, Channeling.

Three types of sedimentary deposits in the Grand Canyon, caused by the differential transport of sediment according to size, are discussed. These types are locally derived alluvial fan debris, cobble bars, and sandy alluvium. The process of sediment addition and removal is reviewed, and the effect of the Glen Canyon Dam upon the sediment budget is considered. The completion of the Dam caused a four-fold reduction in peak discharge of the river sediments, such that new fan debris may increase the gradient through some of the rapids by a factor of 1.8. The major constraint on fluvial transport is structural control. Structural control by canyon walls is indirectly important in providing the sources of alluvial fan debris. The overall river gradient is primarily determined by the balance between addition and removal of coarse debris, as most of the drop in the river occurs in rapids, where debris is contributed by tributaries and rockfalls. The equilibrium between addition and remov-

al of sedimentation is constantly changing, since both processes occur sporadically during times of flood. The morphological context of the debris-fan rapids along with the structurally controlled channel width constitute the major constraints on transport and deposition of cobbles. Some changes have been noted since the completion of Glen Canyon Dam. Post-dam tributary flooding debris deposits are stable at steeper gradients and with a narrower channel. Alluvial fans along the canyon have been noticeably enlarged between 1964 and 1973. The steeper, narrower rapids as well as formation of new rapids will probably continue throughout the lifetime of the Dam. The sand bed will probably readjust, aggrading above the rapids and scouring below. (Baker-FRC)
W82-01338

EROSIVITY 'R' FOR INDIVIDUAL DESIGN STORMS,
Science and Education Administration, Phoenix, AZ. Water Conservation Lab.
K. R. Cooley.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 386-397, 4 Fig, 5 Tab, 11 Ref.

Descriptors: *Nonpoint pollution sources, *Soil erosion, *Design storms, *Rainfall intensity, Pollution load, Agricultural runoff, Model studies, Sediments, Computer models.

In assessing nonpoint source pollution, it is necessary to estimate erosion for individual storms since sediments themselves are pollutants and carry other chemical pollutants. The pollution hazard of many chemicals applied to agricultural lands is restricted to a short period immediately after application because most chemicals deteriorate rapidly. The first few runoff-producing storms after chemical applications are therefore much more important for assessing possible pollution damage than are later storms. Annual runoff calculations are almost meaningless for chemical pollutants. A method was developed which provides R values for individual storm events of any selected standard design frequency and duration for any of the four types of storms defined by the Soil Conservation Services, types I, IA, II, and IIA. A general equation was developed which relates maximum 30 minute intensity for storms of any duration and volume of total precipitation for each type of storm. A computer program incorporating the relationships allows one to quickly and easily determine the erosivity factor R for any type and design storm selected. The effects of types of storms on the erosion potential of any given site can also be easily determined. The method allows designers of conservation measures to determine the range of R values that might be encountered and the most critical combination of storm type and soil conditions. Managers in some areas may use the distribution of erosivity with time to minimize soil loss by proper adjustment of harvesting schedules. (See also W82-01401) (Moore-SRC)
W82-01403

SELECTING A FORMULA TO ESTIMATE SEDIMENT TRANSPORT CAPACITY IN NON-VEGETATED CHANNELS,
Science and Education Administration, Oxford, MS. Sedimentation Lab.
C. V. Alonso.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 25, May, 1980, p 426-439, 3 Tab, 39 Ref, 1 Append.

Descriptors: *Sediment transport, *Sediment-carrying capacity, *Mathematical studies, Forecasting, Hydraulic properties, Computer models, Channel flow.

Sediment transport formulas were investigated in order to select one or more to predict transport capacity of flows in nonvegetated graded channels. The selected formula should: be framed so that it is easy to apply in computer simulation; give the total load of bed material, knowing the hydraulic and geometric properties of the flow; and provide reliable estimates when applied to channels of any size in which sediment particles are transported by the fluid. Eight sediment transport theories were examined with reference to flume and field data. This comparison was based on 40 field measurements and 225 flume experiments. Characteristics of the data were analyzed in terms of four basic dimensionless parameters. The Yang formula was the most reliable over the entire data range. The formulas developed by Ackers and White, Engelund and Hansen, and Laursen, also were found reliable but gave relatively higher errors. Of all the tested formulas, therefore, only the Yang Formula can be used with confidence to predict sand-transport capacity over the range of flow conditions usually encountered in nonvegetated channels. (See also W82-01401) (Moore-SRC)
W82-01405

MODELING EROSION AND SEDIMENT YIELD FROM FLATLAND WATERSHEDS,
Science and Education Administration, Oxford, MS. Sedimentation Lab.
C. K. Mutchler, and C. E. Murphree.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 446-454, 13 Ref.

Descriptors: *Sediment yield, *Erosion rates, *Model studies, *Slopes, Soil erosion, Soil water, Outlets, Drainage, *Agricultural runoff, Storage, Surface water.

The differences in erosion between flatlands and the more sloping lands are dominated by the amount of protective water cover during storm events. This is caused by greater surface storage due to low slope, the bedding type of tillage required for seedbed drainage, higher water tables, generally restricted outlets, and low runoff gradients. The generally higher soil water content and high local slopes of bedding make soil detachment higher and more available for transport, however. A larger part of the sediment probably will originate from the field surface, and fines may be enriched because of lower runoff velocities. Factors of the USLE (Universal Soil Loss Equation) generally were derived using data from slopes exceeding 3% steepness. Few K-factor determinations have been made for flatland soils whose erodibility is affected by their higher soil moistures. Research has lowered the exponent of the slope-length factor for slopes of 0.2% to 0.15% and determined the probable validity of the slope steepness relationship. A few C-factor values have been determined that reflect the wetter flatland conditions and the unique tillage required for drainage. The depositional features of flatlands could be evaluated as sediment delivery ratios to reduce USLE soil loss estimates to sediment yield. Determining soil particle sizes in the USLE-predicted soil loss for determining sediment yield from flatlands is important because of high enrichment of the finer soil fractions in the sediment. (See also W82-01401) (Moore-SRC)
W82-01406

GULLY EROSION,
Science and Education Administration, Columbia, MO.
R. F. Piest, and E. H. Grissinger.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 455-462, 1 Fig, 17 Ref.

Descriptors: *Gully erosion, *Sediment erosion, *Water polluton sources, *Soil properties, Nonpoint pollution sources, surface runoff, Drainage area, Agricultural runoff.

Types and causes of gullying vary from region to region and are ill-defined in the quantitative sense. Therefore, gully erosion rates will not be estimated in the short-term erosion/sedimentation model. If gullying is significant in the sediment accounting of a drainage basin, the gully erosion rate is estimated. Typically, gully erosion rates are highly variable, and have been related to factors both intrinsic to the watershed, and super imposed thereon. Intrinsic factors can include profile adjustments in a drainageway and depth and erodibility of soils and subsoils along the flow boundary. Extrinsic factors include climatic and manmade disturbances. Quantitative information on gully erosion rates has resulted in some empirical prediction procedures, but the state of the art is presently inadequate to define causative processes. Beginning gully length and distance from gully heads to divide are dominant indicators of gully growth. Gully erosion is also related strongly to the size of the drainage basin. Various inadequately defined factors which influence the headward advance of gullies may be accounted for by using past gullying rates calculated from maps or aerial photos. A knowledge of the overall gully erosion problem of a region can help evaluate a given erosion hazard. (See also W82-01401) (Moore-SRC)
W82-01407

SEDIMENT TRANSPORT CAPACITY OF OVERLAND FLOW,
Science and Education Administration, Lafayette, IN.
W. H. Neibling, and G. R. Foster.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 463-473, 5 Fig, 4 Tab, 9 Ref.

Descriptors: *Overland flow, *Sediment transport, *Agricultural runoff, Model studies, Sediment yield, Slopes, Mathematical studies.

Sediment yield from many farm fields is limited by deposition on concave slopes. Deposition occurs when the sediment available for transport exceeds the transport capacity of the flow. Therefore, a relationship for sediment transport capacity of overland flow is a key component of a model designed to estimate sediment yield from agricultural fields. No widely accepted transport equations have been developed for overland flow, but streamflow sediment transport equations often are used. Several streamflow sediment transport equations were examined to determine how well each fit observed overland flow sediment transport data when the equations and their parameters were used directly, without modification or calibration. The equations considered in this analysis were Ackers-White, England-Hansen, Yang, Yalin, Meyer-Peter and Muller, and Bagnold. The Yalin equation can be used without modification to compute sediment transport capacities for overland flow. This equation gives reasonable results for the range of sediment sizes and densities characteristic of agricultural fields, in contrast to some equations that 'blow up' when extended to overland flow conditions. The Yalin equation is recommended for computing sediment transport capacity for both overland flow and concentration flow in channels and waterways on agricultural fields. (See also W82-01401) (Moore-SRC)
W82-01408

CONCENTRATED FLOW RELATIONSHIPS,
Science and Education Administration, Tucson, AZ. Southwest Rangeland Watershed Research Center.
L. J. Lane, and G. R. Foster.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 474-485, 4 Fig, 1 Tab, 4 Ref.

Descriptors: *Agricultural runoff, *Channel flow, *Shear stress, *Model studies, *Sediment transport, Channel erosion, flow rate, Temporal distribution, Mathematical studies, Rill erosion.

The concentrated flow relationships are limited to upland areas typical of farm-field situations. Representative situations include: erosion channel development in areas of fields where flow is concentrated; small channels as permanent features which normally are tilled over during cultivation; and temporary channels developing when rows or ter-

races overtop and flow proceeds cross-contour to the field edge. In this analysis, it is assumed that the peak rate is a characteristic discharge, and that the temporal distribution of shear stress in the channel is triangular. A series of regression equations was developed to estimate friction slope, and thus shear stress for spatially varied flow in triangular channels. These equations gave accurate approximations to friction slopes computed under a wide range of conditions. Once the friction slope is computed, the Yalin sediment transport equation and a critical shear stress equation are used to compute sediment transport, deposition, and detachment for open channel flow in field situations. These equations then are used to route sediment in erodible channels. A simplified channel morphology-sediment yield model was developed to estimate sediment yields and channel widths for channels in soil with a nonerodible boundary below the surface of the soil. In a rill erosion study, the simplified model produced excellent estimates of sediment yield with time, total sediment yield, and final width of the developed rills. (See also W82-01401) (Moore-SRC)
W82-01409

ENRICHMENT RATIOS FOR WATER QUALITY MODELING,
Science and Education Administration, Durant, OK. Water Quality Management Lab.
R. G. Menzel.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 486-492, 1 Fig, 2 Tab, 11 Ref.

Descriptors: *Soil erosion, *Soil chemistry, *Water pollution sources, *Nutrients, Agricultural runoff, Water quality, Nitrogen, Phosphorus, Model studies.

Eroded soil is usually richer in nutrients than the surface soil of the watershed from which the soil comes. This enrichment results from selective erosion of fine soil particles and organic residues. The degree of enrichment must be known to predict effects of soil erosion and erosion control on water quality. Degree of enrichment is expressed as an enrichment ratio, which is the concentration of nutrient in the eroded material divided by its concentration in the soil. Data from different soil and climatic areas were examined to detect possible effects of such factors as soil texture, cropping pattern, or runoff amount on the relationship between enrichment ratios and the amount of soil eroded. With few exceptions, the enrichment ratios for nitrogen and phosphorus in eroded soil decreased markedly with amount of soil eroded. A logarithmic relationship, ln (ER)=2-0.2 in (sed) where (sed) is kilograms per hectare of eroded soil in indvidual runoff events, appears to hold for a wide range of soil and vegetative conditions. Under these conditions, the enrichment ratio probably could be predicted within a factor of 2 for an annual average, and within a factor of 5 for individual runoff events. Terraced fields and sandy soils may not follow this relationship. Nitrogen enrichment changes more rapidly with sediment discharge than phosphorus enrichment. (See also W82-01401) (Moore-SRC)
W82-01410

UNSTEADY ONE-DIMENSIONAL SETTLING OF SUSPENDED SEDIMENT,
Minnesota Univ., Minneapolis. Dept. of Civil and Mining Engineering.
S. Dhamotharan, J. S. Gulliver, and H. G. Stefan.
Water Resources Research, Vol 17, No 4, p 1125-1132, August, 1981. 9 Fig, 17 Ref.

Descriptors: *Suspended sediments, *Sediment deposition, *Settling velocity, Settling basins, Sediment transport, Reservoir silting, Lake sediments, Sedimentation, Turbulent flow, Sediment concentration, Model studies, Mathematical models, Trap efficiency.

To determine how sensitive vertical suspended sediment distributions are to other physical parameters, a numerical model to solve the one-dimensional, unsteady convective-diffusive transport equation was developed. It uses a fully implicit, exponential finite difference scheme and is unconditionally stable regardless of vertical diffusivities and particle fall velocities. A generic study of vertical suspended sediment profiles and sediment trap efficiencies produced results which cover Peclet numbers from zero to infinity. Peclet numbers may be represented by Vh/D, where V is the particle fall velocity, h is the water depth, and D is the mean vertical exchange coefficient. Since particle fall velocity and vertical exchange coefficient are frequently difficult to measure, this model provides a means of simulating the effects of varying these parameters on suspended sediment concentrations and trap efficiences. Where the Peclet numbers are greater than or equal to 20, sediment deposition occurs through downward frontal movement; when less than or equal to 0.2, through columnar precipitation. Residence time is a more important factor than turbulence in determining sediment deposition rate. The generic curves may be useful in design of settling basins and predicting storage loss and reduced water quality in lakes and reservoirs. (Cassar-FRC)
W82-01463

SEDIMENT AND NUTRIENT TRAP EFFICIENCY OF A SMALL FLOOD-DETENTION RESERVOIR,
Scientific and Education Administration, Columbia, MO. Watershed Research Unit.
For primary bibliographic entry see Field 4A.
W82-01471

MANAGEMENT CONCERNS FOR SWIMMING, TUBING, AND WADING IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK,
Great Smoky Mountains National Park, Gatlinburg, TN. Uplands Field Research Lab.
For primary bibliographic entry see Field 6A.
W82-01475

RIVER BED AGGRADATION DUE TO OVERLOADING,
Iowa Univ., Iowa City. Div. of Energy.
S. C. Jain.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY1, p 120-124, January, 1981. 3 Fig, 4 Ref.

Descriptors: *Sediment transport, *Aggradation, *River beds, Degradation, Mathematical equations, Sediment load, *Missouri River.

Reliable quantitative estimates of the future rate and extent of long-term degradation and aggradation would be invaluable to river-management planning, especially along some reaches of the Missouri River. An analytical solution of the aggradation problem was developed, using a boundary condition which was more appropriate than the condition used in a recent analytical model. The boundary condition was based on the observation that the volume of sediment between the initial bed profile (t = 0) and the bed profile at time t must be equal to the volume of additional sediment supplied during this time. Use of the more appropriate boundary condition produces good agreement with experimental data. (Cassar-FRC)
W82-01486

THE EFFECT OF CHANGING SEDIMENT SUPPLY ON SEDIMENTATION IN A GLACIER-FED LAKE,
Illinois Univ. at Chicago Circle, Chicago. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2H.
W82-01510

SUSPENDED SEDIMENT PRODUCTION FROM FORESTED WATERSHEDS ON OAHU, HAWAII,
Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.
R. D. Doty, H. B. Wood, and R. A. Merriam.
Water Resources Bulletin, Vol 17, No 3, p 399-405, June, 1981. 4 Fig, 4 Tab, 12 Ref.

Descriptors: *Watersheds, *Sediment discharge, *Suspended sediments, Water quality standards, Forested watersheds, Agricultural watersheds, Oahu, *Hawaii, Storm runoff, Standards.

Suspended sediments from four forested and two agricultural watersheds on Oahu were sampled for at least 5 years under a variety of storm conditions. Sediment loads were extremely variable among watersheds and within watersheds. Values of suspended sediment discharge in kg per sq km per year were: Kaliki, 20,000-123,000; Kipap, 124,000-617,000; Waikele, 15,000-443,000; Moanalua, 8,400-135,000; Kamoalil (first station), 2,900-721,000; and Kamoalii (second station), 31,900-112,400. Generally, more than 80% of the total suspended sediment was produced in 2% of the time. In a given storm the sediment levels rose rapidly and fell rapidly with time; peak levels were often reached within 2 hours. The great variability makes it difficult to establish effective water quality standards. (Cassar-FRC)
W82-01531

CHANGES IN SEDIMENT STORAGE IN THE COON CREEK BASIN, DRIFTLESS AREA, WISCONSIN, 1853 TO 1975,
California Univ., Los Angeles. Dept. of Geography.
S. W. Trimble.
Science, Vol 214, No 4517, p 181-183, October 9, 1981. 2 Fig, 12 Ref.

Descriptors: *Sediment yield, *Erosion, *Soil erosion, *Coon Creek, *Wisconsin, Sediment distribution, Sediment erosion, River basins, Flood plains, Alluvial plains.

A sediment budget for Coon Creek, Wisconsin, was determined for two periods, 1853-1938 and 1938-1975. The most significant pattern that has emerged from this study is that sediment yield has been small, changing little over the years, compared with either erosion or changes in sediment storage. Upland erosion was severely curtailed in the 1930's, and present sediments are coming from the stored alluvial deposits. Data suggests that sediment yield per unit area may begin to increase with basin size in agriculturally disturbed basins in humid regions, contrary to the widely held concept that sediment yield per unit area decreases with basin size. There are also strong suggestions that yield per unit area at a point in the system can change with time as a result of changes in sediment storage. The mobilization of stored sediment is significant because of pollutants adsorbed onto sediment particles.
W82-01563

2K. Chemical Processes

A COMBINED SALT TRANSPORT-CHEMICAL EQUILIBRIUM MODEL FOR CALCAREOUS AND CYPSIFEROUS SOILS,
Science and Education Administration, Kimberley, ID. Snake River Research Center.
For primary bibliographic entry see Field 5B.
W82-01230

FACTORS AFFECTING THE CHEMISTRY OF PRECIPITATION AND RIVER WATER IN AN UPLAND CATCHMENT,
Aberdeen Univ. (Scotland). Dept. of Soil Science.
J. M. Reid, D. A. MacLeod, and M. S. Cresser.
Journal of Hydrology, Vol 50, No 1/3, p 129-145, March, 1981. 6 Fig, 4 Tab, 21 Ref.

Descriptors: *Precipitation, *Rivers, *Water quality, *Chemical reactions, Water pollution sources, Rainfall, Chemical properties, Soil chemistry, Organic carbon, Glendye, *Scotland, Dye River, Factor analysis, Weathering, Nitrogen compounds, Air pollution, Mineralization, Calcium, Magnesium, Sodium, Potassium, Hydrogen ion concentration, Bicarbonates, Chlorides, Sulfates, Ammonium, Nitrates, Phosphates, Silicon, Iron, Manganese, Aluminum, *Chemistry of precipitation.

The chemistry of precipitation and river water was studied during October 1977 to September 1978 in a 41 sq km moorland catchment at Glendye, Scotland. Precipitation was very dilute (total mean ionic and organic matter, 10.43 mg per liter), weakly acidic (pH 4.33), and highly variable in composition. Compared to the precipitation, Dye River water contained more ionic and organic substances (mean total 39.456 mg per liter), was neutral (pH 6.45), and varied less in composition. Factor analysis suggested that three main processes controlled chemical composition of precipitation: aerosols of oceanic water (Na, Mg, Cl, and total organic carbon), emissions from industries and fossil fuel burning (pH), and windblown terrestrial dust. River water composition was affected by different processes: cation exchange and weathering in the soil (Ca, Mg, Na, bicarbonate, and Si), translocation of elements down the soil profile and into the river during high discharge (Fe, Mn, Al, and total organic carbon), and N demand and mineralization in the soil (ammonium and nitrate). K, Cl, sulfate, and phosphate all showed independent patterns of variation; ammonium and nitrate showed little correlation with discharge but marked seasonal variation. Analysis of river water during two storm events supported the results of the factor analysis, that is, the chemistry of river water is affected by soil processes, suggesting that nearly all the river water originates within the soil, with a minor amount from direct surface runoff. (Cassar-FRC)
W82-01322

RIVER BASIN HYDROSALINITY MODELING,
California Univ., Davis. Dept. of Land, Air and Water Resources.
K. K. Tanji.
Agricultural Water Management, Vol 4, No 1/3, p 207-225, 1981. 3 Fig, 1 Tab, 34 Ref.

Descriptors: *River basins, *Salinity, *Model studies, Australia, United States, Stream discharge, Salts, Solute transport, Groundwater movement, Salt balance, Pollution, Water quality, Computers, Irrigation pratices, Farming, Irrigation effects.

Representative hydrosalinity modeling efforts are reviewed as employed over the past two decades in the Western United States. The potential application of these efforts to the land-stream salinity problem facing Western Australia is investigated. One of the first model systems was the Woods and Orlob Lost River System Model, which combined water-quality data with computer-based modeling efforts. This first model dealt with pesticide residues that appeared to be killing water fowl. This model was followed by a second, which was designed to study low flow conditions in the Sacramento River system. The third major modeling effort was used to evaluate conditions of deteriorating water quality in the lower reaches of the San Joaquin River and their potential salinity impacts on irrigated agriculture. Model 4 was focused on salt balance in the groundwaters of the Upper Santa Ana River Basin, with some consideration on several surface water subsystems. Other models were developed to study the hydrology and total dissolved solids in the Upper Colorado River Basin, the simultaneous simulation of hydrology and salinity, simulation of flow and salinity in a stream/aquifer system in the Arkansas River system in Colorado, the total dissolved solids and nitrogen waste loadings from irrigated agriculture, and the environmental impact of irrigation projects. None of these models has strengths in modeling both water and salts for all three subsystems, soil, groundwater, and stream. It is suggested that, for Western Australia, a first-cut approximation be initially made with more simple models to obtain a fix on probable flow pathways and salt loading. (Baker-FRC)
W82-01469

OXIDATION OF SO2 IN AQUEOUS DROPLETS: MASS TRANSPORT LIMITATION IN LABORATORY STUDIES AND THE AMBIENT ATMOSPHERE,
Brookhaven National Lab., Upton, NY. Dept. of Energy and Environment.
J. E. Freiberg, and S. E. Schwartz.
Atmospheric Environment, Vol 15, No 7, p 1145-1154, 1981. 1 Fig, 2 Tab, 45 Ref.

Descriptors: *Sulfur compounds, *Oxidation, Water, Fluid drops, Water pollution sources, Chemical reactions, Clouds, Fog, *Atmosphere.

The influence of mass-transport limitation on the rate of oxidation of sulfur dioxide to sulfate in aqueous solutions is considered. The aqueous-phase oxidation of sulfur dioxide involves competition between mass transport and chemical reaction. Using the conceptual framework of Schwartz and Freiberg, treating mass transport limitation to the rate of oxidation of sulfur dioxide in aqueous droplets, two laboratory studies were undertaken. As a consequence of aqueous phase mass-transport limitation the reaction reported by Barrie and Georgii, in which the rate of sulfur uptake by suspended aqueous droplets of radius 0.105 cm was determined, may be from 20% to an order of magnitude smaller than the intrinsic rates. Significant gas-phase limitation may have been present as well. Since the high solubility of S (IV) in the presence of ammonia is evident, the contact times employed in the experiments of van den Heuvel and Mason were found to be insufficient for the equilibrium reagent concentration to have been established. Thus the rates derived by Scott and Hobbs from the data of that study are considerably smaller than the intrinsic rates. In a study of the mass transport limitation in relation to fogs and clouds, it appeared that this limitation is not appreciable under ordinary ambient conditions, but may be appreciable at very high oxidation rates, such as high ozone or hydrogen peroxide concentrations. (Baker-FRC)
W82-01470

THE RELEASE OF SOIL PHOSPHOROUS TO RUNOFF IN RELATION TO THE KINETICS OF DESORPTION,
Scientific and Educational Administration, Durant, OK. Southern Plains Watershed and Water Quality Lab.
For primary bibliographic entry see Field 5B.
W82-01477

HYDROCHEMICAL FACIES IN A TERTIARY BASIN IN THE MILLIGAN CANYON AREA, SOUTHWEST MONTANA,
Indiana Univ. at Bloomington. Dept. of Geology.
For primary bibliographic entry see Field 2F.
W82-01481

GASEOUS NITROGEN AS EVIDENCE FOR DENITRIFICATION IN GROUNDWATER,
National Physical Research Lab., Pretoria (South Africa).
J. C. Vogel, A. S. Talma, and T. H. E. Heaton.
Journal of Hydrology, Vol 50, No 1/3, p 191-200, March, 1981. 4 Fig, 1 Tab, 25 Ref.

Descriptors: *Denitrification, *Nitrogen, *Confined aquifers, Groundwater, Nitrates, Argon, Dissolved oxygen, Oxygen, Anaerobic conditions, Aquifers, Microorganisms, Bacteria, *Kalahari Desert.

Very slow denitrification in a confined aquifer was demonstrated by measuring the nitrate, oxygen, and argon concentrations and the N15/N14 ratios in artesian groundwater. The study was conducted in the sparsely populated western Kalahari Desert, which has high concentrations of nitrate from natural sources (rain or bacterial nitrogen-fixing). The ages of the water samples, measured by C14 dating, range from 1300 years to 27,000 years, increasing progressively in a southeasterly direction. Both dissolved oxygen and nitrate decrease with increasing age of groundwater, the nitrate starting to decrease only after all oxygen has disappeared at about 13,000 years. The amount of excess N increases with age and with the decrease in nitrate. The calculated N isotope fractionation factor is comparable to that reported for bacterial cultures. (Cassar-FRC)
W82-01485

2L. Estuaries

LINEARIZED SOLUTION TO INLET EQUATION WITH INERTIA,
Coastal Engineering Research Center, Fort Belvoir, VA.
T. L. Walton, Jr., and F. F. Escoffier.
Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings of the American Society of Civil Engineers, Vol 107, No WW3, p 191-195, August, 1981. 2 Fig, 7 Ref.

Descriptors: *Estimating equations, *Tides, *Inlets, Tidal waters, Flow, Mathematical studies, Friction, Hydrologic aspects, Estuaries.

A solution method is described which employs a linearization technique of equating friction-work over the tidal cycle in a nonlinear approach to friction-work in a linear approach. It avoids the a priori assumptions of the form of bay tide. The method was first used in tidal computations of the Dutch delta works by Lorentz (1926) and was recently applied to inlet-bay problems by Van de Kreeke (1967). The equations are presented for the proposed solution to the hydraulic flow through inlets for simplified inlet-bay type systems. Graphical solutions of some equations are included. (Small-FRC)
W82-01183

EFFECT OF KEPONE ON ESTUARINE MICROBIAL ACTIVITY,
Maryland Univ., College Park. Dept. of Microbiology.
For primary bibliographic entry see Field 5C.
W82-01231

HOLLAND'S EASTERN SCHELDT ESTUARY BARRIER SCHEME: SOME ECOLOGICAL CONSIDERATIONS,
Shell Internationale Research Maatshcappij N.V., The Hague (Netherlands). Group Toxicology Div.
M. Smies, and A. H. L. Huiskes.
Ambio, Vol 10, No 4, p 158-165, 1981. 7 Fig, 35 Ref.

Descriptors: *Barriers, *Environmental effects, *Estuaries, *Flood protection, Planning, Flood control, Dams, Water properties, Sedimentation, Oxygen, Nutrients, *Netherlands, Zeeland.

The possible environmental consequences of construction and use of the Eastern Scheldt Barrier which is being built to protect Zeeland, The Netherlands, from flood waters, are discussed. The project includes the construction of a storm-surge barrier across the mouth of the estuary along with two secondary dams to separate the tidal basin of the Eastern Scheldt from the brackish-fresh water of the Rhine Scheldt shipping route. Turbulence and turbidity will decrease with decreasing mean tidal current velocities, and mean water residence time will increase. Chlorinity and nutrient concentrations depend on water residence time, so these values will be changing. There will probably be increases in net particulate carbon, which may result in increased sedimentation and resulting changes in depth. None of the effects of the barrier will be extreme. If the barrier should be completely closed for over a week, for example, to protect the estuaries from a tanker spill, problems may occur. The estuary may become anoxic, and severe ecological damage could result from lack of oxygen and flooding of the intertidal zone. (Small-FRC)
W82-01375

THE DISTRIBUTION OF MERCURY IN THE SEDIMENTS OF THE PLYM ESTUARY,
Plymouth Polytechnic (England). Dept. of Marine Science.
For primary bibliographic entry see Field 5B.
W82-01390

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

PERIODIC OPERATION FOR DESALINATION WITH THERMALLY REGENERABLE ION-EXCHANGE RESIN. DYNAMIC STUDIES,
Nagoya Univ. (Japan). Dept. of Chemical Engineering.
H. Matsuda, T. Yamamoto, S. Goto, and H. Teshima.
Separation Science and Technology, Vol 16, No 1, p 31-41, 1981. 8 Fig, 4 Ref.

Descriptors: *Desalination, *Ion exchange resins, Water treatment, Sirotherm process, Adsorption, Temperature effects.

A desalination process which uses a thermally regenerable ion exchange resin, Sirotherm TR-20, was studied to improve efficiency, i.e., to decrease the salt concentration in the cold reservoir as fast as possible. In this process, the resin in a basket is alternatively immersed in cold and hot reservoirs. It offers an inexpensive method of desalting low-salinity water where hot water is available in effluents from heat exchangers. A new periodic operation was suggested, on the basis of the observed dynamic behaviors, for the use of this resin. Adsorption isotherms at 10 and 70 C were of the Freundlich type. Surface diffusivity was dependent on the concentration of the liquid phase. Optimal adsorption time was 8 min when desorption time was 10 min. The cost of moving the basket must also be considered in relation to industrial application. (Cassar-FRC)
W82-01341

3B. Water Yield Improvement

MULTIFREQUENCY RADIOMETER DETECTION OF SUBMARINE FRESHWATER SOURCES ALONG THE PUERTO RICAN COASTLINE,
National Aeronautics and Space Administration, Hampton, VA. Langley Research Center.
H. J. C. Blume, B. M. Kendall, and J. C. Fedors.
Journal of Geophysical Research, Vol 86, No C6, p 5283-5291, June, 1981. 8 Fig, 4 Tab, 11 Ref.

Descriptors: *Radiometry, *Submarine springs, *Water supply, *Remote sensing, Microwaves, Springs, *Puerto Rico, Coastal aquifers, Coastal waters.

Submarine freshwater springs were detected along the Puertom Rican coast by remote sensing using the NASA Langley dual-frequency microwave radiometer system in conjunction with an infrared radiometer. The surface above fresh water is about 4 C cooler and 5% cooler in salinity than the surrounding sea water. The first flight on February 4, 1978, investigated 3/4 of the coastal area around the island, not including a portion of the northern coast. The February 6, 1978, flight concentrated on the northwestern coast where several submarine springs had been reported. Springs detected by the radiometer correlated well with reported spring locations. After separating runoff from rivers, lagoons, marshes, and bays, 44 submarine freshwater springs were located. More springs were found than had earlier been estimated. Most of the springs were in the northwest and southeast portions of the coastline. There was a 39% chance of success of finding the same springs on both missions. It is believed that a three-frequency system would reduce the effects of intervals between missions, tides, and winds, which could change locations and intensities of salinity and temperature and of the footprint fill factor. (Cassar-FRC)
W82-01349

3C. Use Of Water Of Impaired Quality

IRRIGATION MANAGEMENT OF COLORADO RIVER WATER WITH INCREASE IN SALINITY,
California Univ., Davis. Dept. of Land, Air and Water Resources.
F. E. Robinson, K. K. Tanji, J. N. Luthin, W. F. Lehman, and K. S. Mayberry.
Transactions of the ASAE, Vol 23, No 4, p 859-865, July/August, 1980. 1 Fig, 7 Tab, 25 Ref. OWRT-A-052-CAL(3).

Descriptors: *Sprinkler irrigation, *Irrigation effects, *Salinity, *Colorado River, Crop production, Crop yield, Agriculture, Saline soils, Leaching.

Steady increases in the salt concentration of the Colorado River at the Imperial Dam have raised concerns about the effects of increased salinity on agricultural productivity on lands irrigated with Colorado River water. Field studies designed to evaluate the effects of salinity increases on crop yields and soil salination involved application of artificially salinated water to crops on a clay and a sandy clay loam by sprinkler irrigation. Significantly lower yields of snap beans, carrots, and onions were produced on plots treated with water having a level of total dissolved solids (TDS) raised to 1,350 milligrams TDS per liter than on plots treated with Colorado River water, which has 875 milligrams TDS per liter. Alfalfa crops receiving the driest irrigation treatment (a ratio of irrigation to pan evaporation of 0.57) suffered significant production yield reductions after 2 years, during which salt accumulated faster than it was applied in the irrigation water. Similar increases in soil salinity were found with the intermediate irrigation treatment (ratio 0.67), but no significant reduction in alfalfa yield was experienced after 32 months. The wettest irrigation treatment (ratio 0.78) resulted in the highest yields and in less salt accumulation in the soil than was applied in the irrigation water, indicating partial leaching. These results indicate that a 50 percent increase in the salinity of the Colorado River system would have only minor effects on most crop yields. Use of the driest irrigation treatment with a 2-year leaching cycle would result in a savings of 34 centimeters of water per year in an alfalfa crop during a time of drought. The wettest irrigation treatment would be preferable when water supplies are adequate. (Carroll-FRC)
W82-01226

WATER RECLAMATION AND REUSE,
Alberta Univ., Edmonton.
S. E. Hrudev.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 751-767, June, 1981. 334 Ref.

Descriptors: *Water reuse, *Water renovation, *Literature review, Bibliographies, Irrigation, Agriculture, Industrial water, Health aspects.

A literature review is presented of publications on water reclamation and reuse published during 1980. Several reviews of current and recent water reclamation and reuse practices in the US, Japan, the Netherlands, and South Africa became available. Papers on water reuse planning and allocation considerations included an evaluation of a series of computer models for water reuse planning. On the topic of agriculture and irrigation, several NTIS bibliographies were published, and studies dealt with such topics as salinity problems associated with municipal and industrial effluent reuse. Several publications reported investigations of the long-term effects of land irrigation with municipal wastewater. Aquaculture and wetland systems received attention in publications including an engineering assessment of aquaculture wastewater systems. Water reuse for groundwater recharge was the topic of a California symposium and other papers. The reuse of industrial water was explored for the pulp and paper industry, the textile industry, and organic chemicals processing; petroleum, coal, and synthetic fuels processing; inorganic chemicals processing, steel mills, metal processing and finishing, recirculating cooling systems and power generation, and other miscellaneous processes. Domestic reuse remained controversial, and health aspects of reclamation and reuse were considered in papers dealing primarily with bacteria and viral pathogens. (Small-FRC)
W82-01252

LAND APPLICATION OF MUNICIPAL WASTEWATER,
Nielson, Maxwell and Wangsgard, Salt Lake City, UT.
For primary bibliographic entry see Field 5D.
W82-01253

A LOOK AT SOME WATER RECLAMATION PLANTS IN SOUTHERN AFRICA,
National Institute for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5D.
W82-01352

EFFECT OF DIFFERENT LEVELS OF WATER SALINITY ON THE DECOMPOSITION OF ORGANIC MANURES IN A BRACKISH WATER FISH POND SOIL,
Central Inland Fisheries Research Inst., Barrackpore (India).
G. N. Chattopadhyay, and L. N. Mandal.
Hydrobiologia, Vol 72, No 3, p 287-292, July, 1980. 2 Fig, 4 Tab, 14 Ref.

Descriptors: *Salinity, *Fish ponds, *Manure, *Decomposition, Organic matter, Brackish water, Saline water, Nutrients, Nitrogen compounds, Nitrates, Dissolved oxygen, Carbon dioxide, Water quality, Animal wastes, Aquaculture, Organic carbon, Soils.

The rate of decomposition of cow dung (at 5% in soil samples) and poultry manure (at 1% in soil samples) was studied in waters of different salinities (0, 10, 20, and 30 ppt) under laboratory conditions. Application of the manures increased the free CO_2 content in the water from 0 in the controls (water containing no manure) to 10.2-11.2 ppm with cow dung and 6.2-7.2 ppm with poultry manure. Dissolved oxygen levels in the control averaged 8.2 ppm; in the manured waters, 5.3-6.1 ppm. The pH values of soil and water declined slightly, about 0.05 to 0.2 units. The amount of nitrogen released from the organic manures to water and soil phases increased gradually with the period of incubation (100 days total) but decreased with increases in water salinity levels. Ammonium levels were always higher than nitrate levels because of anaerobic conditions. As decomposition proceeded, the amount of added organic carbon remaining in the soil decreased, but it increased slightly with increases in water salinity levels. These results suggest that in manuring of fish ponds consideration should be given to the salinity of the water, using well-decomposed manure for ponds with higher salinities. (Cassar-FRC)
W82-01363

NITROGEN BALANCES FOR AN EFFLUENT IRRIGATION AREA,
California Univ., Riverside. Dept. of Soil and Environmental Science.
L. J. Lund, A. L. Page, C. O. Nelson, and R. A. Elliott.
Journal of Environmental Quality, Vol 10, No 3, p 349-352, July-September, 1981. 4 Tab, 12 Ref.

Descriptors: *Nitrogen, *Land disposal, *Irrigation, Wastewater disposal, Impaired water use, Denitrification, Leaching, Ammonium Nitrates, Chlorides, Soil water, Soil solution, Soil-water-plant relationships.

The use of sewage effluent for irrigation in arid regions may result in substantial losses of nitrogen through the leaching of nitrate-nitrogen. Nitrate-nitrogen leaching and nitrogen balances for secondary sewage effluent irrigation systems in California were evaluated and compared with leaching

and nitrogen balances in surrounding plots irrigated with well water. Sampling of soils of the carralitos series (Typic Xeropsamment) at nine effluent irrigation plots showed that field water contents in the unsaturated zone below the root zone varied in space but not in time. Mean nitrate-nitrogen concentrations in the soil solution ranged from 15.4 to 32.4 milligrams per liter and varied significantly in both space and time, as did the mean concentrations of chlorides. Although leaching was found to be a significant process in the effluent irrigation system, it did not differ greatly from leaching in some of the surrounding agricultural fields. Calculation of nitrogen inputs and leaching volumes in conjunction with gaseous nitrogen losses for three of the nine plots studied showed that leaching was the dominant sink, accounting for between 51 and 76% of the applied nitrogen. Crop removal accounted for between about 20 and 40% of the applied nitrogen, while gaseous losses accounted for between 7 and 9% of the nitrogen. Denitrification losses were lower in the effluent-irrigated fields than in nearby agricultural fields. It is suggested that consideration be given to reducing the nitrogen loading rate as a means of reducing leaching losses of nitrogen. (Carroll-FRC)
W82-01478

VEGETATION SELECTION AND MANAGEMENT FOR OVERLAND FLOW SYSTEMS,
Cold Regions Research and Engineering Laboratory, Hanover, NH.
For primary bibliographic entry see Field 5E.
W82-01500

UTILIZATION EFFICIENCY OF NITROGEN FROM SEWAGE EFFLUENT AND FERTILIZER APPLIED TO CORN PLANTS GROWING IN A CLAY SOIL,
Volcani Inst. of Agricultural Research, Bet-Dagen (Israel).
A. Feigin, S. Feigenbaum, and H. Limoni.
Journal of Environmental Quality, Vol 10, No 3, p 284-287, July-September, 1981. 6 Tab, 18 Ref.

Descriptors: *Nitrogen, *Land disposal, *Wastewater treatment, Clays, Corn, Fertilizers, Comparison studies, Mineral water, Ammonium compounds, Nitrogen cycle, Nitrogen compounds, Impaired water use, Agriculture.

In order to achieve the efficient use of nitrogen in sewage effluents by crops, it is first necessary to have a basic understanding of nitrogen transformation in fields irrigated with this effluent. This study investigated the effect of irrigation with sewage effluent on the utilization by plants of the nitrogen in fertilizers and on nitrogen losses from the soil as well as the fate of ammonium nitrogen applied in the sewage effluent and its uptake by plants. Greenhouse experiments using nitrogen-15 as a tracer were used in this study. Ammonium-nitrogen was applied to corn grown in a clay soil in the form of a solid fertilizer, in sewage effluent, and in a mineral solution prepared to simulate the sewage effluent composition. There were no significant differences in the uptake of the ammonium sulfate-nitrogen applied as a solid fertilizer resulting from the type of irrigation water used (demineralized, sewage effluent or mineral solution). About 61 percent of the tagged ammonium-nitrogen applied as sewage effluent was taken up by the corn plants, while 14 percent was immobilized in the organic fraction of the soil. Losses of the tagged ammonium-nitrogen were about 24 percent for the sewage effluent and about 17 percent for the mineral solution. The availability of nitrogen from fertilizer incorporated into the soil prior to seeding or planting appears to be slightly greater than that of ammonium nitrogen applied in sewage effluents used for irrigation. Irrigation with sewage effluent did not affect the recovery of nitrogen applied as solid fertilizer. (Carroll-FRC)
W82-01515

TREATMENT OF SEWAGE PLANT EFFLUENT FOR USE AS MAKEUP WATER,
Burbank, CA.
W. Westbury, E. T. Allen, and J. E. Zoski.
Power Engineering, Vol 85, No 7, p 80-83, 1981. 7 Fig.

Descriptors: *Cooling towers, *Corrosion, Calcium, Phosphates, Wastewater, Water reuse, Fouling, Water treatment facilities, Burbank, California, Wastewater disposal, Effluents, Impaired water use.

A new water treatment system was used to solve the problem of deposits and corrosion in an electric powerplant cooling tower which had been caused by the sewage treatment plant effluent used in the cooling tower. The original plan to use sewage treatment plant effluent for cooling tower water in 1968 was economically motivated. The city paid a disposal fee to the city of Los Angeles for its sewage discharge, and Burbank also paid a fee for city water used as cooling tower makeup. Therefore, Burbank was able to save money on both aspects by using treatment plant effluent for cooling tower makeup. The savings amounted to $500 per million gallons of reused effluent. Over a period of time it was noticed that the efficiency of heat removal in the power plant condensers deteriorated, as indicated by an increasing difference between the condensate temperature and the condenser cooling water outlet temperature. Attempts to control condenser deposition were only partially successful. When the condensers were cleaned in June of 1979 a sample of the deposit was analyzed and shown to be primarily calcium phosphate, which came from the sewage effluent. During this time the plant used the terminal temperature difference (TTD) to monitor condenser efficiency. During the condensor fouling problems, the TTD twice reached 15 F. After the addition of a new agent to control calcium phosphate deposition, the TTD did not rise above 9 F, and the cooling system suffered no condenser fouling, even though the calcium concentration of the cooling water reached a maximum of 440 ppm and the phosphate reached 64 ppm. (Baker-FRC)
W82-01585

3D. Conservation In Domestic and Municipal Use

MANDATORY OR VOLUNTARY WATER CONSERVATION: A CASE STUDY OF IOWA COMMUNITIES DURING DROUGHT,
Iowa State Univ., Ames. Dept. of Sociology and Anthropology.
M. Y. Lee.
Journal of Soil and Water Conservation, Vol 36, No 4, p 231-234, July/August, 1981. 1 Tab, 1 Ref.

Descriptors: *Water conservation, *Water use efficiency, *Water shortage, Drought, Water distribution, User charges, *Iowa, Water policy, Policy making.

The effect of the drought of 1977 on 12 Iowa communities was evaluated by comparing mandatory and voluntary water conservation policies, the types of policy-making bodies involved, the rationales on which the water policies were based, and the effectiveness of the water conservation efforts. The communities all had severe water shortages, and all had the mayor-council form of government. Conservation policies were of two types: four communities adopted mandatory policies, while eight communities stayed with voluntary policies throughout the drought. Most communities adopted qualitative restrictions, mainly dealing with the outdoor use of water; the most widely adopted penalty was a high price for water use beyond the allowed quantity. Communities with mandatory policies rated their policies as more effective than did those with voluntary policies. An objective analysis also found these policies more effective. Policies with a quantitative restriction on a per capita basis achieved the highest degree of conservation. (Small-FRC)
W82-01553

3E. Conservation In Industry

OPTIMUM RECYCLE AND REUSE COOLING SYSTEM DESIGNS USING THE BCT PROCESS,
Tower Systems Inc., Tacoma, WA.
W. C. Sanderson, and R. L. Lancaster.
Industrial Water Engineering, Vol 18, No 3, p 24-30, May/June, 1981. 8 Fig, 7 Ref.

Descriptors: *Cooling towers, *Design criteria, Water treatment facilities, Wastewater treatment, Fouling, *Water reuse, *Industrial water.

Use of the Binary Cooling Tower (BCT) and the process associated with it serves to overcome the limitations on recycling of cooling water available in conventional cooling systems. BCT integrated cooling systems are able to concentrate cooling water wastes up to 150,000 mg/liter total dissolved solids. The plant cooling water is maintained at a solids level which is consistent with conventional cooling systems. The most common form of the BCT cooling process is a cooling system with a BCT and a conventional cooling tower operating in parallel. Blowdown from the conventional system is discharged offsite or to other disposal. This same blowdown in the BCT/tandem system flows into water treatment hardware similar to the raw water treatment system. Tandem cooling systems with a BCT and a conventional cooling tower will operate at a single steady state point with respect to water chemistry, providing the BCT makeup water is cooling tower blowdown. Cooling is shared between the primary cooling water loop and the BCT secondary loop. In cases where the BCT is integrated into cooling systems for the evaporative reduction of wastewater streams in addition to or in place of blowdown, the BCT design must be specified on the basis of annual water flows and evaporation characteristics. When the BCT is being considered for a total wet cooling application, it is designed to exactly the same parameters as a wet cooling tower. In total cooling applications the BCT has the additional operational flexibility of operating wet or dry. BCT integrated systems are also effective in reducing scaling, fouling, and corrosion in the circulating cooling water loop. Some costing information is provided. (Baker-FRC)
W82-01503

3F. Conservation In Agriculture

THE EFFECT OF SNOW TRAPPING AND CROPPING SEQUENCE ON MOISTURE CONSERVATION AND UTILIZATION IN WEST-CENTRAL SASKATCHEWAN,
Department of Agriculture, Swift Current (Saskatchewan). Experimental Farm.
K. J. Kirkland, and C. H. Keys.
Canadian Journal of Plant Science, Vol 61, No 2, p 241-246, April, 1981. 4 Tab, 10 Ref.

Descriptors: *Soil moisture, *Crop yield, *Saskatchewan, Soil moisture retention, Soil absorption capacity, Corn, Wheat, Moisture availability, Available water, Water conservation, Snow, *Snow traps.

The effectiveness of snow trapping methods for conserving moisture for wheat production was investigated. The efficiency of fallow-wheat, fallow-wheat-wheat and continuous wheat in converting annual precipitation into grain production was compared. The results demonstrated that the most effective means of retaining snow for soil moisture storage was to leave standing stubble as in the fallow-wheat-wheat rotation and continuous wheat. Snow ridging on fallow and sunflower trap strips did not significantly increase moisture reserves as compared to bare fallow. Widely spaced corn rows in rotation did increase moisture reserves to levels comparable to those achieved by standing stubble in the continuous wheat rotations. All rotations containing a fallow treatment, with the exception of row-crop fallow, had significantly higher moisture reserves available for the crop seeded on fallow than was available for those crops seeded on stubble in the more extended rotations. Continuous wheat produced higher grain yields and used the available soil moisture to produce more per year than either the fallow-wheat or the fallow-wheat-wheat rotations. (Baker-FRC)
W82-01117

A COMPARISON OF CHEMICAL AND CULTURAL CONTROL OF WEEDS IN IRRIGATION DITCHBANKS,
Regina Research Station (Saskatchewan).
For primary bibliographic entry see Field 4A.
W82-01120

IRRIGATION MANAGEMENT OF COLORADO RIVER WATER WITH INCREASE IN SALINITY,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 3C.
W82-01226

IRRIGATION NEEDS AND YIELD OF RICE ON A SANDY-LOAM SOIL AS AFFECTED BY CONTINUOUS AND INTERMITTENT SUBMERGENCE,
Punjab Agricultural Univ., Ludhiana (India).
B. S. Sandhu, K. L. Khera, S.S. Prihar, and B. Singh.
Indian Journal of Agricultural Sciences, Vol 50, No 6, p 494-496, June, 1980. 4 Tab.

Descriptors: *Irrigation efficiency, *Rice, *Crop yield, Crop production, Irrigation practices, Irrigation requirements, Agriculture, Loam, *India, Seepage loss, *Soil-water-plant relationships.

A practical irrigation schedule was developed for rice that would reduce the irrigation requirement but not the yield. Continuous submergence and irrigation at 1, 3, 5, and 7 days was practiced on rice on a sandy loam. Continuous submergence and irrigations a day after infiltration of ponded water gave comparable grain yields. As the interval between infiltration and irrigation increased, the yield declined. Water requirements were highest with continuous submergence (170 to 204 cm), and percolation losses were large (301 to 483% of evapotranspiration). With 1-day drainage the percolation losses decreased by 32 to 57 cm and with 5-day drainage by 80 to 108 cm. Thus, once transplanted seedlings are established, irrigation can be delayed for some period after infiltration of ponded water. The safe limit of the drainage period depends on the weather. There is a potential savings of 20 to 50% in irrigation water, primarily because of the reduction in seepage losses due to the rapid decline in soil permeability with increasing saturation. (Small-FRC)
W82-01382

INPUT AND OUTPUT CONSTRAINTS AFFECTING IRRIGATION DEVELOPMENT,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6B.
W82-01476

TRICKLE IRRIGATION LATERAL DESIGN ON SLOPING FIELDS,
Louisiana State Univ., Baton Rouge. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 8C.
W82-01537

CHARACTERIZING SPRINKLER DISTRIBUTION PATTERNS WITH A CLUSTERING ALGORITHM,
Rain Bird Western Sales Corp., Glendora, CA.
K. Solomon, and J. C. Bezdek.
Transactions of the ASAE, Vol 23, No 4, p 899-902, 906, July/August, 1980. 2 Fig, 2 Tab, 7 Ref.

Descriptors: *Sprinklers, *Mathematical studies, *Distribution patterns, Algorithms, *Irrigation efficiency, Performance evaluation.

The distribution pattern for a sprinkler, which is affected by the nozzle combination, operating pressure, and the sprinkler model, gives the water application rate as a function of radial distance from the sprinkler. Prior experience or test data may be used to estimate the distribution pattern shape of a given sprinkler, nozzle, and pressure combination. A method for determining the characteristic curve shapes representative of a sprinkler's performance was developed and applied to test data for the Rain Bird 103 Rain Gun sprinkler. The three stages comprising this method are: normalization of the distribution pattern test data, application of the K-Means clustering algorithm to the normalized pattern shapes, and analysis of the resulting cluster membership lists to determine the nozzle size and pressure situations for which each of the prototypical pattern shapes is found valid. The application rate and distance aspects of the distribution test data are converted to dimensionless forms by the distribution pattern normalization process. The resulting vectors, therefore, are quantitative expressions of pattern shape alone. Application of the K-Means clustering algorithm to analysis of a typical gun-type sprinkler indicates that it is an effective and easily implemented method for determining appropriate sprinkler pattern shapes to represent the performance of a sprinkler. This analysis resulted in the identification of three prototype pattern shapes which summarized 42 tests covering 38 combinations of nozzle size, pressure, and trajectory angle. Use of the algorithm reduces the amount of information needed to indicate a sprinkler's performance and permits estimation of distribution pattern data for untested conditions. (Carroll-FRC)
W82-01575

SIGNIFICANT FEATURES OF EMITTER FLUSHING MODE CHARACTERISTICS,
Rain Bird Western Sales Corp., Glendora, CA.
K. Solomon, and J. C. Bezdek.
Transactions of the ASAE, Vol 23, No 4, p 903-906, July/August, 1980. 6 Fig, 1 Tab, 4 Ref.

Descriptors: *Simulation analysis, *Trickle irrigation, *Flushing, *Irrigation engineering, Irrigation design, Simulation, Mathematical studies, Flow channels, Water pressure, Energy, Hydraulics, Flow discharge, Flow control, Fluid mechanics.

Many trickle irrigation systems include automatic flushing emission devices. These emitters have flow channels which allow maximum flow at some pressure which is less than normal operating pressure in order to flush the emitter once during startup and once during shutdown. A simulation model is used to investigate the influence of the shape of an automatic flushing emitter's pressure-discharge curve on the hydraulic behavior of trickle laterals using such emitters. The proposed quantitative formulation of the pressure-discharge relation for typical automatic flushing emitters uses easily obtainable parameters with obvious physical significance. The significant features of flushing emitter pressure-discharge relationships are identified using trickle lateral line simulations based on hypothetical emitter curves. The height and shape of the flushing peak are important features. Lateral line hydraulic requirements were not affected by shifting the pressure at which peak emitter flushing flow occurred, but were negatively affected by increasing the pressure at which the emitters entered the normal emission mode. A trade-off must be made in the selection or design of flushing trickle emitters between the effectiveness of an emitter's flushing action and the potentially excessive flow rate requirements caused by the flushing mode for the system as a whole. While a large, wide flushing spike on an emitter's pressure discharge curve improves flushing effectiveness, it also increases the system flow rate and horsepower requirements. (Carroll-FRC)
W82-01576

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

A COMPARISON OF CHEMICAL AND CULTURAL CONTROL OF WEEDS IN IRRIGATION DITCHBANKS,
Regina Research Station (Saskatchewan).
R. Grover, A. E. Smith, and H. C. Korven.
Canadian Journal of Plant Science, Vol 60, No 1, p 185-195, January, a980. 2 Fig, 6 Tab, 13 Ref.

Descriptors: *Agricultural chemicals, *Irrigation canals, Irrigation design, Irrigation ditches, Leaching, Percolation, Paraquat, Herbicides, Amitrole, Dalapon, *Weed control, Water pollution sources.

Weed control in a series of irrigation ditches was attempted by the use of various herbicidal treatments and cultural methods. The ditches were similar in design to farmer head ditches. Atrazine (22.4 kg/ha), bromacil (15.2 kg/ha), monuron (38.5 kg/ha) and simazine (22.4 kg/ha) were applied during September of 1970 and reapplied during September of 1973. Paraquat (2.2 kg/ha), dalapon plus amitrole-T (11.2 + 2.2 kg/ha), paraquat plus diquat (1.1 + 1.1 kg/ha) as well as chlorflurenol (3.6 kg/ha) were applied annually each June from 1971 through 1976. Sowing was undertaken in 1971 on ditch bottoms and sides with streambank wheatgrass, sheep fescue, Russian wild ryegrass and dwart timothy. Good control of ditch weeds was obtained from 1973-76, with simazine and atrazine giving superior results to monuron and bromacil. The transport of these herbicides in the initial water flush and their leaching into the soil profile were demonstrated to be real hazards for contamination. Trace amounts of amitrole and dalapon were noted in the irrigation water immediately after herbicidal treatment. Maximum hazards from chemical contamination of the irrigation waters, both from the sterilants and the selected foliar herbicides, were found in the initial ponding of the treated ditches. In subsequent irrigations, the residue levels decreased rapidly, confirming that chemical treatments, especially with soil sterilants, may be dependent on the disposal of the initial flush as waste water, either to selected sites as catchment areas or its diversionary disposal into a drain or waste canal to be dissipated by further dilution. (Baker-FRC)
W82-01120

COMBINATION SURFACE-SUBSURFACE DRAINAGE SYSTEMS FOR HUMID REGIONS,
North Carolina State Univ. at Raleigh. Dept. of Biological and Agricultural Engineering.
R. W. Skaggs.
Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol 106, No IR4, p 265-283, December, 1980. 13 Fig, 5 Tab, 22 Ref. OWRT-A-086-NC(6), 14-34-0001-7070.

Descriptors: *Crop production, *Drainage systems, Surface drainage, Subsurface drainage, Corn, *Humid areas, Mathematical models, Water management.

Alternative combinations of surface-subsurface drainage systems were evaluated for corn production at three locations: Columbus, Ohio; Wilmington, North Carolina; and Jacksonville, Florida. Evaluations were conducted for 60 combinations of drain depth and spacing on four separate soils at each location, and attempts were made to relate the results to simpler methods for drainage design. A water management model, DRAINMOD, was used to simulate corn production over a period of at least 25 years. The number of working days during the one-month period before seedbed preparation and SEW30 values during the growing season were predicted. Relationships were determined between the number of working days and the time required for water table drawdown from the surface to a 0.5 m depth, and between SEW30 and the time required for the water table drawdown to a 0.2 m depth. These may provide useful guidelines for first estimates of drainage designs. (Small-FRC)
W82-01228

SEDIMENT OXYGEN DEMAND AND ITS EFFECT ON DISSOLVED OXYGEN IN A CUTOFF MEANDER OF THE KASKASKIA RIVER,
Bradley Univ., Peoria, IL. Dept. of Biology.
B. J. Mathis, and T. A. Butts.

Water Resources Center, University of Illinois, Urbana. Research Report No 162, July, 1981. 40 p, 15 Tab, 8 Fig, 59 Ref, 4 Append. S-072-ILL.

Descriptors: *Dissolved oxygen, *Oxygen demand, *Channeling, Cutoffs, Meanders, *Lotic environment, Fluvial sediments, Oxygen depletion, *Sediments, Oxbow Lakes, Rivers, Channel improvement, Stagnant water, *Kaskaskia River, Illinois.

When a river or stream is channelized, channel modification not only destroys habitat and changes numerous environmental parameters but also alters meanders that have been left behind. In the Kaskaskia River, initial expectations were that cutoff meanders remaining after channelization could provide nurseries for fish and other aquatic organisms. The objectives of this investigation were to (1) evaluate the effects of channelization on dissolved oxygen and sediment oxygen demand in a cutoff meander of a major river; (2) assess habitat potential for fish in relationship to dissolved oxygen during summer months; and (3) evaluate and propose, if feasible, an alternative method of connecting cutoff meanders to the main stream of a river in future channelization projects. When stagnant or no-flow conditions prevailed, anoxic conditions created by sediment oxygen demand were observed in a significant part of the water in the meander. When no-flow conditions prevailed during the summer months, as much as 25 percent of the water in the meander became anoxic, while 65 percent fell below 5.0 mg/l. Sediment oxygen demand rates were more closely related to temperature than to sediment consistency or benthic macroinvertebrate numbers. Ambient sediment oxygen demand measured during the summer was almost three times greater than demand measured during the fall. While sediment oxygen demand in the channelized portion of the river was higher than in some stations in the meander, reaeration resulting from flowing water in the channel was sufficient to prevent anoxic conditions from developing. (Garrison-Omniplan)
W82-01448

SEDIMENT AND NUTRIENT TRAP EFFICIENCY OF A SMALL FLOOD-DETENTION RESERVOIR,
Scientific and Education Administration, Columbia, MO. Watershed Research Unit.
D. L. Rausch, and J. D. Schreiber.
Journal of Environmental Quality, Vol 10, No 3, p 288-293, July-September, 1981. 3 Fig, 2 Tab, 23 Ref.

Descriptors: *Detention reservoirs, *Nutrients, *Sedimentation, Suspended solids, Reservoirs, Flood-control storage, Storm runoff, *Trap efficiency, Sediment yield, Phosphorus, Nitrogen, *Callahan Reservoir, Missouri.

The Callahan Reservoir, a small flood-detention reservoir in central Missouri, was studied over a three year period to determine the sediment and nutrient trap efficiency and to identify factors affecting trap efficiencies. The Callahan Reservoir, which stores 1 centimeter of runoff from its 1,460 hectare drainage area, was found to remove significant amounts of sediment and nutrients from the runoff. The reservoir trapped an average of 85 percent of the incoming sediment, 77 percent of the total sediment phosphorus, and 37 percent of the inorganic nitrogen. Most of the sediment leaving the reservoir was clay. The trapping of sediment and sediment phosphorus during individual storms was related to the concentration of sediment in the runoff. The trapping of phosphorus was influenced by the concentrations of solution and sediment phosphorus. The average trap efficiency was slightly less for nitrate (40 percent) than for orthophosphorus (43 percent). Trap efficiencies for these two nutrients were not related to sediment deposition and could not be predicted on a storm basis by using hydrologic variables. Dissolved organic and hydrolyzable phosphorus had greater outflow than inflow concentrations, which could have been due to biological activity in the reservoir. These results indicate that detention reservoirs can be used as a 'best management practice' to improve water quality downstream from an agricultural watershed. However, the trap efficiencies of these reservoirs may decrease as the reservoirs fill with sediment. (Carroll-FRC)
W82-01471

WATER MANAGEMENT MODEL EVALUATION FOR NORTH CENTRAL OHIO,
North Carolina State Univ. at Raleigh. Dept. of Biological and Agricultural Engineering.
R. W. Skaggs, N. R. Fausey, and B. H. Nolte.
Transactions of the ASAE, Vol 24, No 4, p 922-928, July/August, 1981. 12 Fig, 5 Tab, 17 Ref.

Descriptors: *Water management, *Model studies, DRAINMOD, Resources management, Groundwater management, Water supply, Drainage patterns, Drainage, Drainage water, Artificial drainage, Soil water, *Ohio.

The application of the water management model, DRAINMOD, for an artificially drained soil in North Central Ohio was investigated. DRAINMOD is a computer simulation model for describing the performance of a drainage system on a continuous basis. The model predicts on a day-to-day, hour-to-hour basis the water table position, soil water content, drainage, evapotranspiration and surface runoff in terms of given climatological data, soil and crop properties and design parameters for the water management system to be used. The predominant soil type at the experimental site is Toledo silty clay. Tile and surface flow data were recorded continuously for the growing season each year of the study. Excess irrigation water was applied twice each year in May, June, or July to provide a repeatable 10-year return period storm. Drain flow data for the 8 years were used in this analysis, as the same crop, corn, was grown during these years. Predicted surface runoff and subsurface drainage volumes using DRAINMOD were in good agreement with measured values for all three drainage treatments. Comparisons of measured and predicted relationships showed that the times of occurrence of surface runoff and subsurface drainage events were predicted accurately in almost all cases. While there were some deviations in the magnitude of predicted and measured volumes for individual drainage events, they were usually small and, in most cases, were about the same magnitude as the differences between replications. (Baker-FRC)
W82-01536

IMPACT OF MANAGEMENT PRACTICES ON THE TALLGRASS PRAIRIE,
Colorado State Univ., Fort Collins. Natural Resource Ecology Lab.
W. J. Parton, and P. G. Risser.
Oecologia, Vol 46, No 2, p 223-234, 1980. 5 Fig, 3 Tab, 43 Ref.

Descriptors: *Mathematical models, *Prairies, *Range management, Grasslands, Farm management, Irrigation effects, Nitrogen, Phosphorus, Cattle, Agriculture, Ecology.

The ELM model, which simulates the flow of water, heat, nitrogen, and phosphorus through an ecosystem and the biomass dynamics of plants, consumers, and decomposers, was adapted to a tallgrass prairie site. Range management practices were evaluated, including: altering the grazing intensity, grazing system, and grazing time; addition of nitrogen and phosphorus to the grassland; effects of irrigation; and the effects of spring burning of the prairie. The simulations matched observed data fairly well. The model successfully represented the effects of range manipulations upon primary production, water flow variables, and nutrient cycling, but was less accurate in representing the impact of some range manipulations upon cattle weight gains. A moderately-stocked year-round cow-calf grazing system was more beneficial to the grassland than a highly stocked seasonal steer grazing system, as the cow-calf scheme increased above ground and below ground primary production and plant nutrient uptake. The addition of fertilizer was the best way to increase cattle weight gain. (Small-FRC)
W82-01580

HYDROPOWER--AN OLD TECHNOLOGY FOR A NEW ERA,
Worldwatch Inst., Washington, DC.
D. Deudney.
Environment, Vol 23, No 7 p 16-20, 37-45, September, 1981. 1 Fig, 1 Tab, 77 Ref.

Descriptors: *Hydroelectric power, *Water resources development, *Dams, Reservoirs, Environmental effects, Rural areas, Ecological effects, Energy sources, River basin development, Aluminum, International agreements, *Developing countries, *China, Social aspects, Economic aspects, Political aspects, Irrigation, Erosion, Agriculture, Fisheries, Public health.

Hydropower technology has been available since Roman times. Political and social conditions have affected its use, which decreased in periods of plentiful, cheap labor and increased with the industrial revolution and the 1973 oil shock. Many of the small dams abandoned in the era of cheap oil are being retrofitted, and the Middle Ages technique of fastening waterwheels to floating river barges is being resurrected. Total world hydropower, currently 3,207 trillion watt-hours per year, could realistically expand to 4 to 6 times that amount, considering environmental and economic constraints. Africa taps only 5% of its hydropower potential, while Norway receives 99% of its electricity and 50% of its energy from water. Switzerland exports electricity, and Nepal and Peru have this potential. The largest existing dam, Itiapu, in Brazil-Paraguay, has a 12,600 MW capacity, but this is dwarfed by proposed dams on the Yangtze River, China (25,000 MW) and the Amazon River, Brazil (66,000 MW). Ecological damage can occur--waterborne disease transmission, silting, erosion, inundation of prime agricultural land, soil salinization, soil waterlogging, fisheries destruction, and loss of unique plant and animal species. For undeveloped countries small projects can often provide needed power without the disruptions produced by the large dams. China's policy of building small projects to complement large dams is a model for developing nations. Since the untapped water resources are largely in uninhabited areas, an eventual shift of wealth, population, power, and employment to areas with abundant hydropower production can be expected. (Cassar-FRC)
W82-01593

4B. Groundwater Management

ARTIFICIAL GROUNDWATER RECHARGE,
Water Research Centre, Marlow (England).
J. B. Joseph.
Water Services, Vol 85, No 1024, p 303-304, 307-308, June, 1981. 5 Fig.

Descriptors: *Groundwater recharge, *Artificial recharge, *Underground waste disposal, *Land disposal, Wastewater treatment, Injection wells, Wastewater disposal, Water quality, *Great Britain.

Artificial groundwater recharge is used in Britain for the disposal and reclamation of wastewater. Surface spreading or injection through wells and boreholes can be used. A typical surface spreading scheme capable of recharging 45 M liters/day will require 1.5 to 2 ha of land. While boreholes require less land, they require large scale drilling equipment and complex technology and operation. Chemical as well as physical problems can occur during recharge. Reaction can lead to a deterioration in water quality and clogging or collapse of the aquifer. One advantage of artificial recharge is that a system for resource augmentation can be constructed in phases whose financing and size can be adjusted to meet changes in the demand growth pattern. For example, phase I of the Lea Valley scheme has a yield of 60 M liters/day and was designed and constructed in three years. Water is available for recharge at a marginal cost, typically 25 British Pounds Sterling/M liter. The standard cost for treated water is about 130 British Pounds Sterling. Artificial recharge can also be used for the prevention or reversal of saline intrusion. (Small-FRC)
W82-01110

COST EFFECTIVE GROUND WATER MONITORING,
R. L. Zook.
Ground Water Age, Vol 15, No 9, p 29-31, May, 1981. 3 Fig.

Descriptors: *Groundwater management, *Monitoring, *Costs, Economic aspects, Design criteria, Water management, Management decisions.

Ground Water monitoring systems can be adequate in size and still be cost effective. Cost effective ground water monitoring systems can be designed through low overhead rates, minimum field and laboratory programs to gain maximum data at the lowest possible cost without sacrificing quality, practical designs and solutions, sound management, and adequate communications with the client. Innovations in design and system size should be accompanied by innovation in material types and installation methods and extensive knowledge of materials, technologies, and methods for evaluating an adequate number of alternatives. The major factor that determines which type of multiple setup is installed is how the well system is installed. It is critical to the success of the multiple setup that leakage does not occur between the monitors in the system. Another important factor affecting the cost of multiple setups is whether the aquifer is in bedrock or soil. To obtain overall cost effectiveness, it is necessary that the initial site investigation be cost effective. It is also necessary that an adequate amount of time as well as money be spent in developing the system. (Baker-FRC)
W82-01113

RESULTS OF ACIDIZING WATER WELLS IN ARIZONA,
Hargis and Montgomery, Inc., Tucson, AZ.
D. R. Hargis, and C. A. McCauley.
Water Resources Bulletin, Vol 17, No 3, p 494-497, June, 1981. 2 Fig, 3 Tab, 4 Ref.

Descriptors: *Acidizing, *Well yield, *Water yield, Hydrochloric acid, Aquifers, Confined aquifers, Unconfined aquifers, Carbonate aquifers, Well capacity, Pumping tests, Costs, Groundwater mining, Drawdown, Arizona, Water harvesting, *Arizona, *Groundwater management.

Acidizing is a procedure used to increase production from water wells, and generally consists of placing a nontoxic acid solution in contact with the water bearing formation to dissolve out part of the stratum. Acidizing of sample wells in Arizona was beneficial for wells producing more than 500 gallons per min and marginal for those producing less than that amount. Sample wells for Wellfield No. 1, penetrating the unconfined Coconino Sandstone aquifer, and Wellfield No. 2, penetrating the confined composite Kaibab Limestone-Coconino Sandstone aquifer, were used to collect drawdown data before and after acidizing. Each well was acidized with different amounts of 15% hydrochloric acid according to borehole size and aquifer thickness. Acidizing improved the specific capacity of the Wellfield No. 1 well by 50% at pumping rates of 200-500 gallons per min and of the Wellfield No. 2 well by 100% at pumping rates of 1250-2200 gallons per min. Acidizing reduced the pumping costs in Wellfield No. 1 by 1% at 195 gallons per min to 11% at 500 gallons per min, and in Wellfield No. 2, by 6% at 1250 gallons per min to 11% at 2200 gallons per min. (Cassar-FRC)
W82-01199

POTENTIAL USE OF A STREAM-AQUIFER MODEL FOR MANAGEMENT OF A RIVER BASIN: CASE OF THE SOUTH PLATTE RIVER IN COLORADO,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W82-01301

THERMAL ENERGY STORAGE IN A CONFINED AQUIFER: SECOND CYCLE,
Auburn Univ., AL. Dept. of Civil Engineering.
F. J. Molz, A. D. Parr, and P. F. Andersen.
Water Resources Research, Vol 17, No 3, p 641-645, June, 1981. 10 Fig, 10 Ref.

Descriptors: *Geothermal studies, *Aquifer management, *Energy storage, Subsidence, Groundwater management, Auburn University, *Thermal water, *Injection wells, Wells, Confined aquifers, Water storage.

The second 6-month injection-storage-production cycle of the Auburn University Aquifer Thermal Energy Storage Project, beginning with injection on September 23, 1978, was performed in a similar manner to the first cycle which started March 18, 1978. Water, pumped from an upper supply aquifer and heated to 55 C with an oil-fired boiler, was injected into a deeper storage aquifer, ambient temperature 20 C. By November 25, 1978, 58,010 cu meters of water had been injected. After a 63 day storage period ending January 27, 1979, hot water production began with a initial temperature of 54 C. By March 23 the temperature had dropped to 33 C, and 66,400 cu meters of water and 76% of the injected thermal energy had been recovered. Production ended April 20, at which time 100,100 cu meters of water and 89% of the injected thermal energy had been recovered; the final temperature was 27.5 C. The second cycle differed from the first in the following aspects: (1) well clogging experienced during the first cycle was reduced by regular backwashing (8 times), and the average injection rate increased by 24%, (2) longer production period, 64 days vs. 41 days, and (3) 76% of energy was recovered vs. 66% at the same drop in production temperature to 33 C. During injection the surface elevation near the well rose 4 mm, fell during storage, and continued to fall during production to 0-2 mm above the initial elevation. This movement was caused by thermal expansion and contraction and not by head changes in the storage aquifer. (Cassar-FRC)
W82-01473

EXTRACTION TIMING AND ECONOMIC INCENTIVES FOR GEOTHERMAL RESERVOIR MANAGEMENT,
Woodward-Clyde Consultants, San Francisco, CA.
K. Golabi.
Journal of Environmental Economics and Management, Vol 8, No 2, p 156-174, June, 1981. 3 Fig, 2 Tab, 11 Ref.

Descriptors: *Geothermal resources, *Conservation, Water conservation, Resources development, Natural resources, *Cost analysis, Economic aspects, Costs.

A model is presented to consider various methods of extraction for a hot water geothermal reservoir, with emphasis on the optimal time to begin extraction. One major objective was to demonstrate how a profit-maximizing firm can determine an optimal extraction plan for a liquid-dominated reservoir, including an investigation of the sensitivity of the decision variables to such parameters as the perceived rate of growth of the value of energy, discount rate, royalties, and the penalties that can be imposed by regulatory agencies for delaying extraction. Of equal importance is the objective of providing public sector resource trustees and regulatory agencies with a model of entrepreneurial activity that can be used to study the effect of various incentives and penalties on the timing and extraction rate of geothermal resources. In the model presented, the economic life of the reservoir can go beyond breakthrough time, with the production of steam continuing until either it is not economical or it is not technically feasible to do so. It is assumed that the brine is extracted from the aquifer, and cycled through heat exchangers where the heat energy is extracted to generate steam, and the cooled brine is reinjected into the aquifer. The economic inducements studied include pre-exploitation rents and penalties and royalties. The substantial variation of starting time with penalty and royalty suggest that these kinds of economic incentives could motivate a profit-maximizing entrepreneur to accelerate or postpone production. However, if the entrepreneur's alternative rate of return is high enough, these inducements will have little effect. The optimal pumping rate decreases as royalty increases. Thus royalty can be considered an effective means for conservation. As royalty is increased, exploitation time is deferred and, when production begins, it is undertaken at a slower rate. (Baker-FRC)
W82-01504

DISCUSSION-ENGINEERING GEOLOGY OF ARID AREAS,
Water and Power Resources Service, Sacramento, CA.
N. P. Prokopovich.
Bulletin of the Association of Engineering Geologists, Vol 17, No 2, p 95-99, Spring, 1980. 1 Fig.

Descriptors: *Arid-zone hydrology, *Water resources development, Deserts, Arid lands, Arid zone, Semiarid lands, Arid climates, *Groundwater, Irrigation, Leaching, Capillarity, Water supply development.

It is anticipated that areas presently viewed as deserts will, in the future, be valuable as agricultural areas, dependable source areas for solar energy, and mining and recreational-residence areas. Imported water will be a necessary item. Extensive pumpage of local ground water for irrigation can create an overdraft of groundwaters in any climatic zone, but is most likely to do so in arid or semiarid climates. Such overdrafts will lead in some cases to land subsidence, which could interfere with deliveries of surface water to areas of demand by canals. Groundwater development is generally less expensive than construction of a long conveyance import system, and probably will precede such construction. Another cause of subsidence is an increase in weight of dry sediments due to wetting with irrigation water, and corresponding compaction of unconsolidated underlying sediments. Irrigation can also lead to a buildup of shallow groundwater bodies, resulting in slope instability and a change in chemistry of groundwaters and soils. Leaching of salts would be an obvious result of importing relatively pure water into a desert. Leaching may cause loss of strength of originally hard-cemented rocks and may lead to slope failures and land sliding. The salts may eventually move and accumulate in depressions, resulting in local concentrations of salts. Drainage problems and disposal of drain water are critical in arid regions. There are no standard patterns for geologic investigations in deserts. Each project must be treated individually. (Baker-FRC)
W82-01568

4C. Effects On Water Of Man's Non-Water Activities

WATER QUALITY FROM TWO SMALL FORESTED WATERSHEDS IN SOUTHERN ILLINOIS,
Illinois Univ. at Urbana-Champaign. Dept. of Forestry.
R. J. Brozka, G. L. Rolfe, and L. E. Arnold.
Water Resources Bulletin, Vol 17, No 3, p 443-447, June, 1981. 1 Fig, 4 Tab, 25 Ref.

Descriptors: *Water quality, *Forest watersheds, *Nutrient removal, Forest hydrology, Intermittent streams, Watersheds, Streamflow, *Illinois, Nitrates, Phosphorus, Water yield, Logging.

Intermittent streams in two similar, forested watersheds in Illinois were monitored for flow volume and water quality during 1977-79 to establish a baseline prior to clearcutting one watershed in November 1979. Dominant species in both stands were oak and hickory. Annual flow varied widely between years and between watersheds. Although water quality was high in both watersheds there were significant differences between watersheds in Na+, Mg(2+), K+, Ca(2+), and nitrate; P showed no difference between watersheds. The most pronounced seasonal trend was in nitrate levels, which rose during the dormant season, peaked in February-March, and declined during the growing season. (Cassar-FRC)
W82-01140

EFFECTS OF LOGGING ON MACROINVERTEBRATES IN STREAMS WITH AND WITHOUT BUFFER STRIPS,
California Univ., Berkeley. Dept. of Forestry and Conservation.
For primary bibliographic entry see Field 5C.
W82-01227

STORM FLOW RESPONSE TO ROAD BUILDING AND PARTIAL CUTTING IN SMALL STREAMS OF NORTHERN CALIFORNIA,
Pacific Southwest Forest and Range Experiment Station, Arcata, CA.
R. R. Ziemer.
Water Resources Research, Vol 17, No 4, p 907-917, August, 1981. 7 Fig, 7 Tab, 19 Ref.

Descriptors: Flood peak, *Logging, *Road construction, Streamflow, Forest management, *Casper Creek, *California, Runoff, Evapotranspiration, Forest watersheds, *Storm runoff, Hydrographs, Peak discharge.

A total of 174 paired storm hydrographs from two sections of the Casper Creek watershed in northern California were analyzed. Selective cutting (67% removal) and tractor yarding (15% of land surface for roads, etc.) of a 85-year-old second growth redwood and Douglas fir forest in the South Fork of the watershed did not significantly change large peak streamflows as compared with the North Fork control area. The South Fork mean peak discharge was only 4% larger than that of the North Fork. However, early fall storms produced a 300% increase in peak discharge because evapotranspiration had ceased at the end of the growing season. These storms were all small and produced minor peaks. During the late fall and winter after recharge of soil moisture, both parts of the watershed had similar peak discharges. The most significant variable explaining the difference between the logged and unlogged watersheds was the annual storm number divided by the amount of watershed logged. (Cassar-FRC)
W82-01295

ESTIMATION OF IMPERVIOUS-AREA WASHOFF PARAMETERS,
Geological Survey, Reston, VA.
W. M. Alley.
Water Resources Research, Vol. 17, No 4, p 1161-1166, August, 1981. 4 Fig, 1 Tab, 12 Ref.

Descriptors: *Impervious surfaces, *Urban runoff, *Water quality, Florida, Rainfall-runoff relationships, Model studies, Urban watersheds, Rainfall intensity, Runoff, Water pollution sources.

The exponential washoff equation, commonly used in models for rainfall runoff water quality in urban areas, is often modified by an availability factor to account for the effects of runoff intensity on pollutant washoff. This study showed that, overall, the inclusion of the availability factor did not significantly improve results. However, techniques for determining the optimum values of coefficients used in these equations have been demonstrated. These procedures were applied to a 6 ha urban watershed in south Florida, where the optimized parameter values vary widely between different storms and between different constituents. (Cassar-FRC)
W82-01465

ANOMALOUS SNOWFALL CAUSED BY NATURAL-DRAFT COOLING TOWERS,
Rand Corp., Santa Monica, CA.
For primary bibliographic entry see Field 2B.
W82-01512

4D. Watershed Protection

ECONOMIC IMPACTS OF EROSION AND SEDIMENTATION CONTROL PLANS: CASE STUDIES OF PENNSYLVANIA DAIRY FARMS,
Cornell Univ., Ithaca, NY. Dept. of Agricultural Economics.
G. B. White, and E. J. Partenheimer.
Journal of Soil and Water Conservation, Vol 35, No 2, p 76-78, March/April, 1980. 4 Tab, 8 Ref.

Descriptors: *Soil conservation, *Farming, *Erosion control, Conservation, *Dairy industry, Pennsylvania, Economic aspects, Profit, Income, Sedimentation, Soil management, Legal aspects, Regulations, *Case studies.

Analyses of 12 Pennsylvania dairy farms using linear programming models showed that implementation of the state's Clean Streams Law, which requires erosion and sedimentation control, would reduce net income on 10 of the farms. The greatest anticipated income reduction was 29%. Six farms had income reductions of 6-29%. Average costs for implementing the plans were $6,420 (range $705-$14,128) without cost sharing and an average of $2,522 with cost sharing. Greatest damage to income was produced by unprofitable crop rotation (any reduction in corn silage decreased farm income). The most efficient conservation practice for all 12 farms was no-till corn. Other helpful measures were rotation changes and cover crops. This analysis suggests a flexible approach with respect to soil loss limits. Present maximum allowable soil losses, 2-4 tons per acre, may be too restrictive in some cases. The goal should be a significant reduction in soil loss rather than an absolute limit. (Cassar-FRC)
W82-01134

ANALYSIS OF NATIONAL WATER POLLUTION CONTROL POLICIES 2. AGRICULTURAL SEDIMENT CONTROL,
Resources for the Future, Inc., Washington, DC.
For primary bibliographic entry see Field 6A.
W82-01293

RESIDUE AND TILLAGE EFFECTS ON SCS RUNOFF CURVE NUMBERS,
Science and Education Administration, Beltsville, MD.
W. J. Rawls, C. A. Onstad, and H. H. Richardson.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May 1980, p. 405-425, 5 Fig, 7 Tab, 21 Ref, 1 Append.

Descriptors: *Conservation tillage, *Agricultural runoff, *Runoff rates, Rainfall-runoff relationships, Model studies, *Erosion control.

The effects of conservation tillage on reducing direct runoff ranges from slight to substantial. Soil Conservation Service (SCS) procedures used today for estimating runoff do not consider the effects of conservation tillage and no-till practices on runoff. To develop the SCS runoff curve numbers for these practices, tillage and crop data were assembled from small watersheds and plots under natural and simulated rainfall from many locations across the country. The residue left on the ground was chosen as the independent variable to represent the effects of conservation tillage practices. These data were studied to determine runoff curve numbers for single and double cropping systems under various conservation tillage practices. There are not enough data to derive an equation for predicting how conservation tillage affects runoff. Data compiled from plots and small watersheds under simulated and natural rainfall for 531 events were used, however, to develop graphs that can be used as practical guides to estimate the decrease in SCS runoff curve numbers due to a certain amount of residue on the ground or a certain percentage of the surface covered with residue. Separate guides were developed for corn and for such medium-residue crops as wheat, oats, sorghum, and soybeans. (See also W82-01401) (Moore-SRC)
W82-01404

SOIL CONSERVATION PROBLEMS AND PRACTICES: A FARMER VIEW.
Journal of Soil and Water Conservation, Vol 36, No 4, p 186-193, July/August, 1981.

Descriptors: *Soil erosion, *Erosion control, *Farming, Agriculture, Soil erosion, Salinity, Soil compaction, Wind erosion, Agricultural engineering, Farm management.

Seven prominent farmers and ranchers discussed the severity of soil erosion, voluntary vs. mandatory erosion control programs, and the prospects for the adoption of conservation tillage. Problems the farmers were experiencing included water and wind erosion, soil compaction, salinity, and absentee landlords. Changes noted during these farmers' careers included trends toward more machines and less help, more sophisticated irrigation practices, and the extensive use of chemical fertilizers. Conservation practices in use included terracing, minimum tillage, sprinklers and drip irrigation, residue management, and chisel plowing. Conservation tillage, including stubble-mulch tillage and chemical weed control were being practiced in most areas. Government action to require conservation tillage was viewed as a controversial topic. The benefits of conservation tillage were agreed upon by all farmers interviewed. (Small-FRC)
W82-01551

EROSION AND SEDIMENTATION CONTROL IN REGIONAL AND SITE PLANNING,
Pennsylvania State Univ., University Park. Dept. of Landscape Architecture.
B. K. Ferguson.
Journal of Soil and Water Conservation, Vol 36, No 4, p 199-204, July/August, 1981. 13 Fig, 1 Tab, 40 Ref.

Descriptors: *Erosion control, *Sediment control, *Regional development, Planning, Site selection, Environmental effects, Construction, Land use, Vegetation, Land management, Land cover.

Methods available to regional and site planners for minimizing erosion and sedimentation on construction sites are summarized. Illustrations of small hypothetical sites are included. The methods include: land use compression, or getting the same amount of development within a smaller land area; land use distribution, which involves putting the compressed development on the most suitable portion of the site; and facility orientation and adaptation, which involves fitting roads and buildings into a site by shaping and orientation. Also, land grading can be used, which involves shaping the land around the developed facilities, and vegetation and land cover can be used to control erosion. After construction, diversions and chutes can help divert water flows, and land covers can be useful. Preconstruction planning is the most effective means of controlling erosion and sedimentation. (Small-FRC)
W82-01552

SOIL EROSION CONTROL IN IDAHO'S COW CREEK WATERSHED: AN ECONOMIC ANALYSIS,
Idaho Wheat Growers Association, Boise.
S. H. Berglund, and E. L. Michalson.
Journal of Soil and Water Conservation, Vol 36, No 3, p 158-161, May/June, 1981. 4 Tab, 12 Ref.

Descriptors: *Erosion control, *Soil erosion, *Economic aspects, *Farm management, Watershed management, Cost analysis, Fallowing, Precipitation, Sedimentation, Soil management, Crop yield, Crop production.

Precipitation, topography and soil treatment factors make erosion a persistent problem on agricultural land in northern Idaho's Cow Creek watershed. A five point program involving cross-slope farming divided slope farming, minimum tillage, treating critical erosion areas, and restricting summer fallow was proposed to control the erosion problems of this watershed and was evaluated economically. Average costs of the program would range from $5 to $9/acre, depending on the crop rotation system used. High costs occur when income is foregone by planting less profitable crops, higher production costs are incurred and/or yields are reduced. Of the five points proposed to control erosion, treating critical areas would be the most costly, amounting to over 50% of the total program's projected expense. The rest of the costs are divided nearly equally among divided-slope

and contour farming and minimum tillage, with negligible costs being incurred by restricted summer fallow. Since continuous cropping rotation is more profitable to Cow Creek farmers, summer fallow is only used in cases of severe drought or weed infestation. (Geiger-FRC)
W82-01556

MANAGING LAND TO MEET WATER QUALITY GOALS,
Economics and Statistics Service, Washington, DC. Natural Resource Economics Div.
C. Osteen, W. D. Seitz, and J. B. Stall.
Journal of Soil and Water Conservation, Vol 36, No 3, p 138-141, May/June, 1981. 18 Ref.

Descriptors: *Water management, *Water resources development, *Watershed models, *Erosion control, *Management planning, Land management, Watershed management, Water use, Water quality management, Soil conservation, Soil erosion, Model studies.

Under Section 208 of Public Law 92-500, provisions are made for land management to control soil erosion by traditional methods. This approach is termed source control. A second approach, water-based land management (WBLM), relates the choice of land management practices and their locations to water use and water quality goals. The applications of the WBLM are discussed. The implementation of WBLM may be more difficult on the institutional level than 208 plans in agricultural areas. Under a WBLM plan, nonlandowners may be excluded from decisions in which they feel they have an interest. To allow nonlandowners to vote on WBLM motions, changes may have to be made in state soil conservation district laws. The availability of analytical tools and information will affect the WBLM planning process. Physical process models should estimate water quality parameters in conjunction with land management plans. The use of WBLM for controlling washloads and bedlods in agricultural watersheds is considered. Three sediment movement models, ANSWERS, ARM and CREAMS, which may be used in WBLM programs are described. Linear prgramming models used to manage land used for agricultural activities in a watershed should not be impossible to integrate into a WBLM plan. Other factors in integrating models into WBLM systems are discussed. The long range benefits of WBLM planning should justify the extra costs and efforts involved in its implementation. (Geiger-FRC)
W82-01557

DEBRIS FLOWS IN SMALL MOUNTAIN STREAM CHANNELS OF COLORADO AND THEIR HYDROLOGIC IMPLICATIONS,
Denver Univ., CO. Dept., of Geography.
For primary bibliographic entry see Field 2E.
W82-01597

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

A SIMPLE LOW COST APPARATUS FOR CONDITIONING LARGE VOLUMES OF WATER FOR VIROLOGICAL ANALYSIS,
Institut Armand-Frappier, Laval (Quebec). Centre de Recherche en Virologie.
P. Payment, and M. Trudel.
Canadian Journal of Microbiology, Vol 26, No 4, p 548-550, 1980. 1 Fig, 1 Tab, 5 Ref.

Descriptors: *Viruses, *Water analysis, *Sampling, Measuring instruments, Microbiological studies, Filtration, Adsorption, Separation techniques, Laboratory equipment.

A Simple low cost proportioning injector is described which can effectively add chemicals such as aluminum chloride, hydrochloric acid, and sodium thiosulfate, to condition large volumes of water to detect viruses by adsorption to selected filters. This system can function at about one-tenth the cost of the bulky hydraulic proportioner. Its use should simplify the virological analysis of water, particularly for laboratories with limited funds and facilities. When drinking water is to be conditioned, two injectors are connected in-line, one for hydrochloric acid and aluminum chloride, and a second one to add sodium thiosulfate to neutralize residual chlorine. (Baker-FRC)
W82-01123

PERSISTENCE OF PSEUDOMONAS AERUGINOSA IN CHLORINATED SWIMMING POOLS,
Toronto Univ. (Ontario). Dept. of Microbiology and Parasitology.
P. L. Seyfried, and D. J. Fraser.
Canadian Journal of Microbiology, Vol 26, No 3, p 350-355, 1980. 1 Fig, 4 Tab, 22 Ref.

Descriptors: *Swimming pools, *Bacteria, *Chlorination, Chlorine, Recreation facilities, Disinfection, Acidity, Water treatment, Pseudomonas aeruginosa, Coliforms.

A study was conducted to determine the effect of the pool bather load, free chlorine residual, and pH on the incidence of Pseudomonas aeruginosa in swimming pools and to investigate the survival of specific P. aeruginosa serotypes and phage types in a chlorinated pool environment. A total of 179 Toronto and Peterborough swimming pools were sampled between May and September of 1974. The pool types included 18 above and below ground private pools as well as 59 public outdoor and 102 public indoor pools. Surface and subsurface samples were collected. Out of 266 water samples taken in 1974, P. aeruginosa was detected in 8 (21%) of the 38 private pool samples, 4 (3%) of the 124 public indoor pool samples, and 7 (7%) of the 104 public outdoor pool samples. A 36% increase in surface water counts was found compared with subsurface levels. The pH of samples ranged from 6.9 to 7.8 and the water temperature was between 22 and 32.5 degrees C. Bather load at time of sampling ranged from 0 to 25 swimmers, with the exception of one day when 120 bathers were present. The highest P. aeruginosa estimate of 2400 CFU/ml was recorded in a pool water with a bather load of 10, a temperature of 31 degrees C, and a free chlorine residual of 0.0 mg/liter. P. aeruginosa was not found in 146 samples from pools with a free chlorine level greater than 0.4 mg/liter. This study confirms other reports suggesting that single strains predominate when high counts of P. aeruginosa occur in pool waters. (Baker-FRC)
W82-01124

USE OF EXCISED ROOT CULTURES AS BIOINDICATORS OF WATER POLLUTION (UTILISATION DES CULTURES DE RACINES ISOLEES COMME TEST BIOLOGIQUE DE POLLUTION DES EAUX),
Paris Univ. (France).
M. Richez, A. Kovoor, and R. Heller.
Environmental Pollution (Series A), Vol 22, No 1, p 1-10, May, 1980. 1 Fig, 7 Tab, 4 Ref.

Descriptors: *Water analysis, *Plant tissues, *Bioindicators, *Pollutant identification, Water pollution effects, Rivers, Tomatoes, Root development, Cultures, Sein River, Marne River, *France.

Excised roots from the tomato, Lycopersicon esculentum, or other plants highly sensitive to pollutants and capable of rapid growth in vitro, can be used as bioindicators for early detection of freshwater pollution. The test consists of 2 parts: (1) 10 days of in vitro culture in the water sample with added nutrients, and (2) 48 hours exposure in sterilized dialysis bags in the river itself, followed by 8 days immersion in running water in the laboratory. Root growth is compared with controls at the end of the test period. In one test, length of tomato roots was 78 mm in distilled water, 96 mm in 2.5% river water (Marne), and 44 mm in 80% river water. In similar tests with water from the River Seine, the control roots were 87 mm long; in 25-100% river water roots were 26-30 mm. (Cassar-FRC)
W82-01133

PETROLEUM HYDROCARBONS IN SEDIMENTS OF SAGINAW BAY, LAKE HURON,
Michigan Univ., Ann Arbor. Dept. of Atmospheric and Oceanic Science.
P. A. Meyers, N. Takeuchi, and J. A. Robbins.
Journal of Great Lakes Research, Vol 6, No 4, p 315-320, 1980. 3 Fig, 20 Ref.

Descriptors: *Oil pollution, *Lake sediments, Pollutant identification, Lakes, Sediments, Organic compounds, Hydrocarbons, *Saginaw Bay, *Lake Huron.

A 60 cm sediment core from Saginaw Bay was analyzed to produce a profile of petroleum contamination over the last 200 years. Aliphatic hydrocarbons averaged 385 micrograms per g in modern sediments and gradually decreased to 30 micrograms per g in sediments deposited before 1976. An unresolved complex mixture of hydrocarbons indicative of petroleum comprised 90% of the total concentration in all core sections deposited over the last 100 years. Although some of these nonbiogenic hydrocarbons may originate from natural sources, such as forest fires and erosion of ancient sediments, it is conservatively estimated that 20,000 to 40,000 tons of petroleum have been deposited in Saginaw Bay in the last 100 years. (Cassar-FRC)
W82-01141

ABUNDANCE OF ORGANIC COMPOUNDS IN WATER,
Illinois Environmental Protection Agency, Springfield.
D. J. Schaeffer, and K. G. Janardan.
Bulletin of Environmental Contamination and Toxicology, Vol 24, No 2, p 211-216, 1980. 1 Tab, 8 Ref.

Descriptors: *Organic compounds, *Water pollution, *Toxicity, *Industrial wastes, *Waste identification, Statistical methods, Pollution load, Pollutants, Environmental effects, Probabilistic process, Mathematical studies, Probability distribution, Frequency distribution, Marking techniques.

A data base for organic compounds in water was established by Shackelford and Keith. In this data base 1,258 compounds appearing in 5,720 observations on 33 water types were tabulated. A total of 175 lists which give the identities and frequencies of occurrence of organic compounds were compiled. Such data constitute the type of information which will be obtained by broad-based monitoring programs. A theoretical model was developed for analyzing the data to provide information applicable to specific compounds. The probability function governing the appearance of a compound on merged lists is identical to the Generalized Geometrical Distribution. According to this calculation, there is only a 14% chance of a specific compound being found in a given list. The maximum number of times a given compound could be expected to appear on several lists is 6. If a given compound appears more frequently than this, it suggests that its absolute rate of occurrence and detection is greater than anticipated. The low frequency of occurrence makes it unlikely that inferential procedures will be developed based on decreased frequencies of observation. The data bases may be analyzed in subsets such as finished drinking waters or specific industrial categories, and relevant estimates may be obtained to guide the collection and interpretation of new data. (Titus-FRC)
W82-01162

ALTERATIONS IN THE BOD PROCEDURE FOR THE 15TH EDITION OF 'STANDARD METHODS FOR THE EXAMINATION OF WATER AND WASTEWATER',
Iowa State Univ., Ames. Dept. of Civil Engineering.
J. C. Young, G. N. McDermott, and D. Jenkins.
Journal of the Water Pollution Control Federation, Vol 53, No 7, p 1253-1259, July, 1981. 12 Ref.

Descriptors: *Biochemical oxygen demand, *Standards, *Water quality, Sample preparation, Water analysis, Dissolved oxygen, Nitrification, Wastewater.

Additions to and changes in the biochemical oxygen demand test procedure in the 15th edition of Standard Methods are described. The major changes are in sections dealing with immediate dissolved oxygen demand, sample storage, dilution water quality check, nitrification inhibition, seeding, and use of standards as a check on technique. The reasons for the modifications are also discussed. The changes will improve the utility and understanding of BOD analysis. In this edition, no provision for the separate measurement of immediate dissolved oxygen demand is made, and the maximum storage time for a sample was reset to six hours. On the topic of dilution water quality, the dilution water dissolved oxygen uptake after 5 days of incubation at 20 deg C must not exceed 0.2 mg/liter and should not exceed 0.1 mg/liter. A test for nitrification inhibitions was included because of the problems that nitrification in BOD test causes in interpreting plant performance and stream load impact. (Small-FRC)
W82-01186

ORGANOCHLORINE INSECTICIDES AND PCB IN SURFICIAL SEDIMENTS OF LAKE MICHIGAN (1975),
Ontario Ministry of Agriculture and Food, Guelph. Pesticide Residue Lab.
R. Frank, R. L. Thomas, H. E. Braun, D. L. Gross, and T. T. Davies.
Journal of Great Lakes Research, Vol 7, No 1, p 42-50, 1981. 6 Fig, 3 Tab, 18 Ref.

Descriptors: *Chemical wastes, Lakes, *Lake Michigan, *Insecticides, DDT, Chlordane, Endrin, Heptachlor epoxide, HEOD, Mirex, Polychlorinated biphenyls, Sediments, Lake sediments, Great Lakes.

Attempts were made to map the concentration of organochlorine insecticides and PCBs in the upper 3 cm of the bottom sediments in Lake Michigan in order to establish base levels and identify sources to enable future trends to be assessed. Samples of Lake Michigan sediment were collected using a Shipek bottom sampler. Analyses of 286 surficial sediments revealed the presence of DDT, its metabolites DDE and TDE, HEOD, chlordane, heptachlor epoxide (HE), and polychlorinated biphenysl (PCB), but no detectable residues of endrin, endosulfan, methoxychlor or mirex. The mean residue of total DDT for bottom sediments of the whole lake was 11.9 mg/g. The highest mean residue of total DDT occurred in the Milwaukee basin, at 40.79 ng/g, with the metabolites representing about 80% of the total DDT concentration. HEOD was identified and measured in 48.3% of sediments taken from the lake bottom, with 42.0% having residues between 0.1 and 1.0 ng/g. The highest mean residue occurred in the Waukegan basin. Chlordane was identified in 21.6% of the samples, with a calculated mean residue for the whole lake of about 0.37 ng/g. Highest residues occurred in the Grand Haven and Sarian basins. Heptachlor epoxide was identified in 53.9% of the samples, with the mean residue level being 0.67 ng/g. Ninety of the 286 samples (31.5%) contained no residues of the three cyclodienes, HEOD, chlordane, or heptachlor epoxide. PCBs were found in 79.6% of samples, with 67.4% of them containing 2 to 20 ng/g levels. Sixty-two sediments were analyzed for mirex, with no residues being found to a level of 0.2 ng/g. No residues of endosulfan, its sulfate, endrin, or methoxychlor were detected to a limit of 0.2 ng/g. (Baker-FRC)
W82-01190

MONITORING LEACHATE IN GROUND WATER BY CORRECTED RESISTIVITY METHODS,
Wisconsin-Milwaukee Univ. Dept. of Geological Sciences.
W. F. Kean, and R. B. Rogers.
Bulletin of the Association of Engineering Geologists, Vol 18, No 1, p 101-107, 1981. 7 Fig, 1 Tab, 10 Ref. OWRT-A-077-WISC(3).

Descriptors: *Resistivity, *Leachates, *Monitoring, Fly ash, *Path of pollutants, Leacing, Contamination, Groundwater pollution, Sampling, Electrical properties, Water quality, Waste disposal, Landfills, Measuring instruments, *Pollutant identification.

Seasonal variations in temperature from 2 to 18 C affected surface electrical resistivity readings at a landfill site, where fly ash leachate movement was monitored. Therefore, laboratory determinations were made of resistivity of samples from well borings in the study area as a function of temperature, saturation, and salinity. A Wenner electrode configuration with 1 inch electrode spacing was used to measure resistivity. After correction, the surface resistivity measurements positively identified the leachate movement. (Cassar-FRC)
W82-01219

GEOLOGIC AND HYDROLOGIC FACTORS CONTROLLING RADON-222 IN GROUND WATER IN MAINE,
Maine Univ. at Orono. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W82-01222

DETERMINATION OF LABILITIES OF SOLUBLE TRACE METAL SPECIES IN AQUEOUS ENVIRONMENTAL SAMPLES BY ANODIC STRIPPING VOLTAMMETRY AND CHELEX COLUMN AND BATCH METHODS,
State Univ. of New York at Binghamton. Lab. for Trace Methods and Environmental Analysis.
P. Figura, and B. McDuffie.
Analytical Chemistry, Vol 52, No 9, p 1433-1439, August, 1980. 4 Fig, 4 Tab, 29 Ref. OWRT-B-070-NY(2).

Descriptors: *Water analysis, *Trace metals, *Heavy metals, Chemical analysis, Rivers, Pollution load, Chemical properties.

The development and application of a method for differentiating trace metal species on the basis of relative lability is presented. The method developed for solutions of Cd, Cu, Pb, and Zn utilized anodic stripping voltammetry and Ca-Chelex resin in successive column and batch procedures. By using a characteristic time scale for the measuring technique, species were classified as 'very labile', 'moderately labile', 'slowly labile', or 'inert'. For species in each category, a range of dissociation rate constants can be estimated. A precise determination can be made at the ppb and sub-ppb levels using preconcentration of the various fractions. Applications include samples from the St. Lawrence River, Susquehanna River, a Hudson River Estuary, and secondary sewage effluent. In general, Zn and Cd were in the 'very' or 'moderately' fractions, Cu was in the 'moderately' fraction, and Pb was 'slowly labile' or 'inert'. This method can be used to yield detailed information on the various chemical forms of soluble trace metals in polluted or unpolluted waters. (Small-FRC)
W82-01229

TENAX-GC EXTRACTION TECHNIQUE FOR RESIDUAL POLYCHLORINATED BIPHENYL AND POLYAROMATIC HYDROCARBON ANALYSIS IN BIODEGRADATION ASSAYS,
Tennessee Univ., Knoxville. Dept. of Microbiology.
M. P. Shiaris, T. W. Sherrill, and G. S. Sayler.
Applied and Environmental Microbiology, Vol 39, No 1, p 165-171, January, 1980. 1 Fig, 6 Tab, 16 Ref. OWRT-B-040-TENN(2).

Descriptors: *Biodegradation, *Surface water, *Hydrocarbons, Assay, Bioassay, Chlorinated hydrocarbons, Biphenyls, Phenanthrene, Aroclor 1254.

The usefulness of Tenax-GC as an extraction polymer for biodegradation samples was evaluated. The factors affecting the efficient recovery of both PAH and PCB were determined. The method was quantitatively efficient and reproducible for phenanthrene, but variable and not quantitative for Aroclor 1254. Aqueous sample volumes and varying concentrations of organic matter influenced polychlorinated biphenyl and polyaromatic hydrocarbon extraction efficiency. Phenanthrene recovery was decreased by soil extract but unaffected by spent bacteriological culture medium. Both types of organic matter caused significant reduction of Aroclor 1254 recovery. Polyaromatic hydrocarbon and polychlorinated biphenyl biodegradation assays, performed with reservoir samples, supported the laboratory evaluation. This study demonstrated the utility of the Tenax-GC extraction technique for phenanthrene analysis in biodegradation assessment. However, Tenax-GC extraction was not appropriate for Aroclor-1254 biodegradation studies. (Baker-FRC)
W82-01235

INORGANICS,
Pope Scientific, Inc., Menomonee Falls, NI.
D. S. Polcyn.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 620-649, June, 1981. 1 Tab, 1004 Ref.

Descriptors: *Water analysis, *Pollutant identification, *Reviews, Chromatography, Spectroscopy, Potentiometers, Neutron activation analysis, Sample preparation, Heavy metals, Trace elements, Speciation.

This review of 1004 recent papers on analytical methods for inorganic constituents of water samples is basically an index to the references. It is divided into types of methods (gas and ion chromatography, voltammetric methods and their subdivisions, potentiometric methods, pH analysis, selective ion electrodes, atomic absorption spectroscopy and its subdivisions, inductively coupled plasma emission spectroscopy, atomic emission spectroscopy, ultraviolet and visible spectroscopy, fluorescence and chemiluminescence, X-ray flourescence and emission, neutron activation analysis), and analyses for specific constituents such as individual elements, oxygen demand, cyanide, and asbestos. The author also discusses new analytical chemistry books, sampling and sample storage, sample purification and concentration, heavy metal analysis, trace level analysis, instrumentation, speciation, and mass spectrometry. (Cassar-FRC)
W82-01238

ORGANICS,
Washington Univ., Seattle.
F. B. DeWalle, D. Norman, J. Sung, E. S. K. Chian, and M. Giabbai.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 659-674, June, 1981. 8 Tab, 165 Ref.

Descriptors: *Water analysis, *Organic compounds, Detergents, Pesticides, Industrial effluents, Monitoring, Water quality, Pollutant identification, Measuring instruments, Surfactants, Chemical analysis, Reviews, Biochemical oxygen demand, Chemical oxygen demand, *Total organic carbon, Streams.

The biochemical oxygen demand, chemical oxygen demand, and total organic carbon of various industrial wastes were compiled and analyzed using computers. The concentration of TOC (total organic carbon) in a flowing stream was estimated from the time of sampling. Several studies used direct extraction or preconcentration on a resin column to remove detergents from the water phase, followed by high pressure liquid chromatography or gas chromatographic separation and mass spectrometric identification. Analytical methods were also developed to determine hydrocarbons. The use of advanced analytical techniques for determination of pesticides, chlorinated hydrocarbons, and related compounds generally involves capillary GC columns using liquid phases such as OV-101, SE-54 or Carbowax 20 M. Single or multiple stage cleanup was generally required to separate the pesticides from the background organics. Preconcentration was required when the organics were present at low concentrations. Naturally occurring organics were also analyzed in water. Due to their polar nature, derivatization prior to GC was generally required. The most commonly used method was HPLC, with or without derivatization. UV, fluorescence or electrochemical detectors were employed. Low molecular weight compounds were concentrated through steam extrac-

tion or purging of the liquid phase. Numerous compounds such as the priority pollutants have been found in wastewaters, leachate or wastewater effluents. Aerobic and anaerobic degradation was observed for several compounds, whereas adsorption onto solids generally paralleled the octanol/water partition coefficients. Unit processes that were effective in removing the chemicals included activated carbon, wet oxidation, and UV/peroxide. (Baker-FRC)
W82-01239

CONTINUOUS MONITORING, AUTOMATED ANALYSIS, AND SAMPLING PROCEDURES,
Oak Ridge National Lab., TN.
W. W. Pitt Jr.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 675-678, June, 1981. 63 Ref.

Descriptors: *Water analysis, Reviews, *Water quality, Water monitoring, *Monitoring, Wastewater analysis, Computers, *Sampling, Sample preservation, Sample preparation, Biological oxygen demand, *Wastewater analysis.

Recent research advances in the area of monitoring, analysis and sampling for water quality are cited in this review article. Much work has been done on of monitoring strategies and sampling protocols. The need for a well documented quality control system in wastewater monitoring has been recognized and is described; assistance is available from the EPA for establishing such a system. Sampling of effluents from the pulp and paper industry as well as analysis for priority pollutants has received attention. Continuous monitoring systems have been developed, including on-line monitoring and monitoring of receiving waters. An automated system for near-real-time water quality monitoring is undergoing field testing at an experimental wastewater reclamation facility. A computer-automated system for total organic carbon has been installed at two US EPA laboratories in Cincinnati. Biological monitoring systems have included work on a new concept of biological monitoring of industrial effluents using bluegill sunfish as sensors and a small on-line computer to follow the ventilatory rates of fish. Immobilized enzymes and living microorganisms have been used in sensors for wastewater monitoring. Automated analyses continue to be increasingly important in monitoring water quality, as is reflected in several literature reviews. An automated method for the direct determination of microgram levels of organic carbon in potable waters has been developed. Sampling procedures suitable for use with automatic analyzers have been developed and are discussed in relation to the type of samples required, sample storage, and reproducibility of results obtained. New methods of sample preservation have also been developed. (Baker-FRC)
W82-01240

BIOASSAYS - PROCEDURES AND RESULTS,
Ecological Analysts, Inc., Sparks, MD.
A. F. Maciorowski, J. L. Sims, L. W. Little, and E. D. Gerrard.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 974-993, June, 1981. 363 Ref.

Descriptors: *Bioassay, *Toxins, *Reviews, Literature reviews, Bioindicators, Fish, Toxicity, *Ecological effects, Monitoring, Environmental protection, Water quality, Planning, Algae, Invertebrates, Symposium, Conferences.

Various workshops and symposia have been held to deal with the suitability of laboratory methods for predicting ecosystem effects and the future of toxicology as a predictive science. Toxicity testing has proved valuable in the prediction of the environmental impact of chemicals. Regulatory aspects of biological criteria and monitoring have been investigated with special reference to the NPDES permit program. Aquatic research programs conducted and managed by the EPA were outlined, and research dealing with sublethal effects of pollutants in the sea and their effects on the physiology of marine organisms is cited. A compilation was recently published dealing with technical papers on water quality criteria for European freshwater fish. Detailed toxicity test procedures and techniques were provided for finely divided solids, pH, temperature, ammonia, dissolved oxygen, chlorine, zinc, copper and cadmium. Other tests have indicated that zebra fish provide an excellent screening test for potential toxicity. Current research is also cited which deals with the design, interpretation and strategy of bioassays; the use of bacterial bioassay test methods; assays conducted with algae and other plants; the effects of contaminated sediments on marine benthos; pollution effects on fish and amphibians; comparative testing with aquatic organisms from various trophic levels; the impact of pollution on organisms as studied through microcosms and in situ testing; the use of short term bioassays for mutagenicity and cellular toxicity; and additional studies dealing with health effects assays. (Baker-FRC)
W82-01277

MICROBIOLOGY OF WATER,
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5B.
W82-01284

MICROBIOLOGY: METHODOLOGY AND QUALITY ASSURANCE,
Environmental Protection Agency, Cincinnati, OH.
R. H. Bordner.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1098-1107, June, 1981. 120 Ref.

Descriptors: *Microbiological studies, *Quality control, *Literature review, Bibliography, Microorganisms, Bioassays, Water quality.

A literature review is presented of papers published in 1980 on the topic of methodology and quality assurance in microbiology. Research in this area deals with many applications of methodology including sampling, direct test, most probable number, membrane filter, plating, biomass, and identification procedures. Methods to provide more rapid results, to compensate for environment stress, and to screen for toxic materials utilizing bacterial bioassays were emphasized. Rapid method studies included the use of ATP concentrations to show the impact of potential pollutants on aquatic environments, and pyrolysis gas-liquid chromatography for identifying bacteria in sewage treatment effluents. In the area of quality assurance, the adequacy of individual results and accuracy of samples collected for bacteriological analysis of surface waters were evaluated using statistical techniques. The MF technique was evaluated in a polluted beach study, and a standard practice was published for enumerating microorganisms of health and sanitary significance. (Small-FRC)
W82-01285

MICROBIOLOGY: DETECTION, OCCURRENCE, AND REMOVAL OF VIRUSES,
Louisiana State Univ., Baton Rouge.
D. Roy, M. Tittlebaum, and J. Meyer.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1138-1142, June, 1981. 47 Ref.

Descriptors: *Viruses, *Fate of pollutants, *Water treatment, *Pollutant identification, Microbiological studies, Indicators, Shellfish, Adsorption, Wastewater disposal, Reviews.

Most of the new developments in detection and isolation of viruses in water samples use the adsorption-elution technique on filter media. For example, the tentative standard method recovered 0.7-32% of enteroviruses, but four major groups of enterviruses were inactivated by the glycine-NaOH reagent at pH 11.5. Evaluation of three filter media and three cell lines showed fiberglass filters and BGM cell line to be most desirable for virus recovery procedures. Virus survival was the subject of several studies. In general, seawater completely inactivated viruses within 72-96 hours. Other aspects of virus survival reported are the effects of detergents, thermoinactivation in sediments, and effects of rainfall on land applied wastewater sludge. Factors affecting virus persistence in land irrigated with wastewater treatment plant effluent were mixing time, pH, concentration of virus, and isoelectric points of both virus and adsorbent. Virus removal was 98% on a coal and sand filter bed and 99% with an added sedimentation step. In the soil, most adsorption occurred in the top 20 cm; clays were more efficient than sands and organic soils. An improved detection method for low levels of viruses in oysters, clams, and mussels was reported. Bovine parvovirus was suggested as an indicator for viruses. Fecal coliforms and fecal streptococci were not good indicators. (Cassar-FRC)
W82-01290

METAL ION CONCENTRATIONS ASSOCIATED WITH LATE SUMMER SEDIMENTS OF THE OHIO RIVER,
Louisville Univ., KY. Dept. of Chemical and Environmental Engineering.
H. T. Spencer, C. A. Leuthart, and R. S. Colyer.
Water Resources Research, Vol 17, No 4, p 959-962, August, 1981. 2 Fig, 3 Tab, 7 Ref.

Descriptors: *Metals, *Sediments, *Heavy metals, Fate of pollutants, *Ohio River, Rivers, McAlpine Pool, Pollutant identification, Aquatic life.

The Ohio River, which has been transformed into a series of long flowing lakes by 19 high lift dams for navigation, deposits a fine brown sediment during low flow in late summer. Fine sediment samples collected in McAlpine Pool contained an average of 3% (maximum 4.5%) volatile solids (dry weight). Most of the COD, H, Na, K, Al, Mn, and Pb and a significant amount of C, Cr, Fe, Cu, and Zn were associated with the volatile solids. Only Mg was associated with the nonvolatile solids. Highest concentrations of heavy metals (in micrograms per g) in the 24 samples were as follows: Cr, 87; Mn, 1719; Cu, 30; Zn, 275; Cd, 3.9; and Pb, 67. Analysis of a pooled sediment sample showed 11.0 + or - 0.8 micrograms thorium per g and 1.4 + or - 0.5 micrograms uranium per g. Since the fine sediment collects along the river banks in fish fry feeding areas, the metals contained in the sediment have the potential for entering the food chain. (Cassar-FRC)
W82-01300

PERIPHYTON ANALYSIS FOR THE EVALUATION OF WATER QUALITY IN RUNNING WATERS OF GREECE,
Athens Univ. (Greece) Inst. of Systematic Botany.
A. Economou-Amilli.
Hydrobiologia, Vol 74, No 1, p 39-48, September, 1980. 5 Fig, 2 Tab, 42 Ref.

Descriptors: *Water quality, *Periphyton, *Bioindicators, Streams, Fate of pollutants, Algae, Levadia, *Greece, Diatoms, Springs, Self-purification, Cyanophyta, Species diversity, Saprobity, Water pollution effects.

Periphyton species growing on stones, twigs, and plant life were analyzed according to Kothe's 1962 ecological method of evaluating water quality, combined with Knopp's 1955 and Kadlubowska's 1978 methods of estimating frequency of individuals. The test site was a rapidly running stream, forming cascades, near the sources of springs in Levadia, Greece. Of the 8 sampling stations, 2 were littered by tourists, 1 was marked with large oil spots and tripton, 2 were charged with wastewater influent, and 3 were free of noticeable impurities. Cymbella prostrata (Berkeley) Cleve was established as an obligatory species standard. The indicator species numbers ranged from 26-30 in the three clean sites to 8-13 in the remaining sites. The results are also graphically expressed as the percentage values of the species deficit. There was a remarkable absence of decomposers, showing the lack of heavy pollution even at the sites receiving effluent, probably a result of the turbulence and high oxygen content of the stream. (Cassar-FRC)
W82-01358

FAECAL POLLUTION OF BELGIAN COASTAL WATER,
Institut d'Hygiene et d'Epidemiologie, Brussels (Belgium).
M. Yde, and S. De Maeyer-Cleempoel.
Marine Pollution Bulletin, Vol 11, No 4, p 108-110, April, 1980. 1 Fig, 3 Tab, 8 Ref.

Descriptors: *Coastal waters, *Pollutant identification, *Belgium, *Feces, *Coliforms, Streptococcus, Bacteria, Indicators, Municipal wastewater, Agricultural runoff, Wastewater.

There is a high risk of pollution from domestic and agricultural sewage along the Belgian coast due to discharges from one river, three channels, and five urban sewage outfalls along the 60 kilometer stretch. Coliforms, fecal coliforms, and fecal streptococci were selected as indicators of fecal pollution in the Belgian coastal waters. The density of these organisms was highest on the coastline and decreased with increasing distance from the shore. Significant numbers of the indicator bacteria were found at 5 kilometers from the coastline. The densities of the organisms were similar in surface and deep-sea samples. Fecal bacteria densities appear to be moderated by warm climatological conditions. These results indicate that the Belgian coastal waters are not seriously fecally polluted. None of the samples taken 0.5 kilometers off shore exceeded swimming water standards set by the European Economic Community, and less than 15 percent exceeded standards for coliforms or fecal coliforms. (Carroll-FRC)
W82-01373

ATOMIC ABSORPTION SPECTROPHOTOMETRIC STUDIES OF CADMIUM AND ZINC IN COMMERCIAL FERTILISERS, SOILS AND RIVER WATERS,
Aligarh Muslim Univ. (India). Environmental Research Lab.
For primary bibliographic entry see Field 5B.
W82-01388

RAPID METHODS OF CHEMICAL ANALYSIS USED IN EMERGENCY RESPONSE MOBILE LABORATORY ACTIVITIES,
Municipal Environmental Research Lab., Edison, NJ.
M. Gruenfeld, U. Frank, and D. P. Remeta.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 165-172, 4 Fig, 2 Tab, 33 Ref.

Descriptors: *Chemical anaysis, *Hazardous materials, *Pollutants, *Gas chromatography, *Infrared spectroscopy, *Fluorescence spectroscopy, Sediments, Water analysis, Quantitative analysis, Quality control, Sample preparation, Soil contamination, Oils, Pollutant identification.

The EPA's Oil and Hazardous Materials Spills Branch (OHMSB) maintains two analytical laboratory facilities: an in-house laboratory and a mobile laboratory. The mobile laboratory provides a prompt on-site chemical analysis facility to support cleanup activities in emergency situations. The in-house laboratory has developed the rapid, direct analytical methods used in the confined space of the mobile laboratory. Gas chromatography using flame ionization detectors and electron capture detectors can be used for quantitative determination of priority pollutants in water, sediments, soils, and abandoned storage tanks and drums. Synchronous exicitation fluorescence spectroscopy has been automated and is used in the quantitative determination of hazardous materials and petroleum oils in water and wet sediments. Infrared spectroscopy is used to identify and quantify petroleum oils following rapid extraction from water and sediments. These methods were used at emergencies at nine sites and supported decisions on response and cleanup. A specialized analysis and safety protocol was developed which eliminates time consuming solvent extraction and concentration procedures. A rapid, simple technique for artificially weathering petroleum oil and a procedure for removing elemental sulfur from sediments are in use. A comprehensive quality assurance/quality control protocol has been implemented to ensure the acquisition and dissemination of high quality data. (Brambley-SRC)
W82-01431

LABORATORY PROCEDURE FOR ESTIMATING RESIDUE DYNAMICS OF XENOBIOTIC CONTAMINANTS IN A FRESHWATER FOOD CHAIN,
Columbia National Fisheries Research Lab., MD.
For primary bibliographic entry see Field 5B.
W82-01443

PRELIMINARY REPORT OF STREAM SAMPLING FOR ACIDIFICATION STUDIES 1980,
New York State Dept. of Environmental Conservation, Albany.
J. R. Colquhoun, J. Symula, M. Pfeiffer, and J. Feurer.
Technical Report No 81-2, September, 1981. 36 p, 14 Fig, 1 Tab, 14 Ref, 2 Append.

Descriptors: *Acid streams, *Fish populations, *Acidic water, *Hydrogen ion concentration, Fisheries, Stream fisheries, Fish stocking, Annual runoff, On-site data collections, *Fish toxins, Fish management, Fish conservation, Adirondack streams, Lakes, Catskills, *New York.

Fish resources in the Adirondack lakes in New York provide a unique opportunity for readily accessible fishing for native and stock salmonids. Loss of this opportunity due to acidification would have serious recreational, economic, and ecosystemic consequences. Depending on the duration and extent of pH depression, fish reproduction may be inhibited, young fish may be killed, or lethal conditions for adult fish may result. During the spring snowmelt runoff, stream pH is inversely related to discharge, with the effect most severe in areas with thin soil on non-calcareous bedrock. Results of a spring 1980 study indicate that some Adirondack streams were affected by depressions of pH and alkalinity. Other streams remained acidified throughout most of the summer, while a large number of streams never reached pH levels potentially lethal to fish (below 5.0) during 1980. None of the sampled streams in the Catskills reached critical pH levels during the survey period; however, snowfall during the 1979-80 winter was abnormally low. Indices of fish populations in Adirondack streams were found to be statistically correlated with spring 1980 pH measurements. These measurements then serve as indications of past effect. Approximately 15 percent of the streams were in a 'critical' classification (a mean equilibrium meter pH reading below 5.0), but this percentage is biased by the selection of streams. It was felt that a larger proportion of all Adirondack streams was probably affected by low pH conditions in 1980, and there would be an even higher proportion after a normal winter. (Garrison-Omniplan)
W82-01453

MERCURY IN THE MUSCLE TISSUE OF FISH FROM THREE NORTHERN MAINE LAKES,
Maine Univ. at Orono; and Columbia National Fisheries Research Lab.
For primary bibliographic entry see Field 5B.
W82-01459

THE APPLICATION OF MUTAGENICITY TESTING TO DRINKING WATER,
Water Research Centre, Stevenage (England).
R. Forster, and I. Wilson.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 3, p 259-274, May, 1981. 3 Fig, 7 Tab, 46 Ref.

Descriptors: *Mutagens, *Drinking water, *Water analysis, Pollutant identification, Bacteria, Salmonella, Carcinogens, Raw water, Treated water, England.

Twenty-one unconcentrated samples from English raw and treated waters were examined for mutagenic properties using Salmonella tester strains. A chlorinated sewage effluent, which contained histidine, and one treated lowland water produced repeated positive results. Concentration procedures were also evaluated. Partial freeze drying concentrated the organic material most efficiently, having a mean total organic carbon recovery of 101.1% with a concentration rate of 6.3-12 fold. Freeze concentration, which concentrated the sample 6-11 fold, gave a mean total organic carbon recovery of 54.1%. However, samples concentrated by the freezing methods did not produce reliable results in mutagenic testing. A comparison of freeze drying/solvent extraction and XAD-2 resin adsorption/solvent desorption showed that the XAD-2 process was cheaper, less time-consuming, and more selective. High performance liquid chromatography showed promise as a method of fractionating the concentrate to further trace and identify the mutagenic materials. (Cassar-FRC)
W82-01487

RELATIONSHIP OF THE RAW WATER QUALITY TO MUTAGENS DETECTABLE BY THE AMES SALMONELLA/MICROSOME ASSAY IN A DRINKING-WATER SUPPLY,
National Inst. for Water Research, Pretoria (South Africa).
W. O. K. Grabow, P. G. Van Rossum, N. A. Grabow, and R. Denkhaus.
Water Research, Vol 15, No 9, p 1037-1043, September, 1981. 2 Fig, 2 Tab, 33 Ref.

Descriptors: *Mutagens, *Drinking water, *Organic compounds, Pollutant identification, Water quality, Water treatment, Water analysis, Chlorination.

Mutagens detected by the Ames test were related to water quality parameters in the water from the Vaal River, the drinking water supply for Parys, South Africa. The treatment process was conventional: flocculation, sedimentation, sand filtration, and chlorination. Correlations were obtained between mutagenic activity of non-volatile compounds in dichloromethane extracts and volatile halogenated hydrocarbons. Limited correlations were seen between mutagenic activity and total organic carbon contents of raw and treated water. The dry mass of extracts from neither raw nor treated water correlated with these parameters. Mutagenic activity increased in spring, probably because of increased amounts of mutagen precursors washed into the river with the first rains of the season, rising temperature, and increased algal action. With increased flow, mutagenic activity decreased and reached a stable summer level. No activity was detected in raw water, indicating that mutagens in wastewater effluents discharged 40 km upstream had been removed or inactivated. Mutagenic activity in the drinking water was 75-100 induced TA98 revertants per 100 micrograms dry extract in the absence of 89 liver preparation. Values in this range are reported for other potable water supplies. The mutagens consisted mainly of neutral organic compounds, including polycyclic hydrocarbons. The importance of routine mutagenic activity monitoring was emphasized. (Cassar-FRC)
W82-01493

U.V.-DOC CHARACTERIZATION OF PULP AND PAPER BLEACH EFFLUENTS,
Department of Scientific and Industrial Research, Wellington (New Zealand). Industrial Processing Div.
C. N. S. McLachlan.
Water Research, Vol 15, No 8, p 983-988, August, 1981. 10 Fig, 1 Tab, 17 Ref.

Descriptors: *Pulp wastes, *Organic matter *Ultraviolet radiation, Pulp and paper industry, Industrial wastes, Kraft mills, Wastewater treatment, Design criteria, Chemical analysis, Pollutant identification, Flocculation, Separation techniques.

A method for the characterization of pulp and paper bleach effluents was developed, and the aluminum salt flocculation characteristics of the effluent organic components were examined. Ligninsulphonic acid was used as a model substance, and aluminum salts were used as precipitants. U.V.-DOC and U.V.-pH plots were obtained by sequential precipitation of organic material from both

kraft and sulphite bleach effluents and were used to characterize the organic material in the effluent. The plots also provide useful information on the likely degree of purification to be achieved by different treatment processes. The plots of U.V. absorbance versus DOC produce a straight line and permit the accurate estimation of the non-U.V. absorbing DOC in effluent. Thus, DOC loadings can be estimated when designing effluent treatment systems for the highly colored, not readily biodegradable lignin-derived organic material found in pulp and paper bleach effluents. (Small-FRC)
W82-01495

A NOTE ON THE USE OF MEMBRANE FAECAL COLIFORM MEDIUM FOR ENHANCING RESOLUTION AND ACCURACY WHEN ENUMERATING A SMALL PLAQUING COLIPHAGE,
Western Australia Univ., Nedlands. Dept. of Microbiology.
W. F. Parker.
Journal of Applied Bacteriology, Vol 51, No 1, p 81-84, August, 1981. 2 Fig, 7 Ref.

Descriptors: *Culture media, *Viruses, *Bacteriophage, Agars, *Pollutant identification, Coliforms, Microbiological studies, Water analysis.

The resolution and accuracy of bacteriophage M52 plaque enumeration in water samples were improved by modifying a membrane fecal coliform medium (mFC) according to Geldreich, et al. (1965). The host strain was grown overnight in nutrient broth, the plates flooded with the culture, and excess liquid removed by draining and drying. The drop count technique was used to apply the inocula. After incubation, plaques on mFCA (mFC broth base plus agar) were more clearly resolved and more readily enumerated than plaques grown on Trypticase Soy agar. (Cassar-FRC)
W82-01507

THE ESCHERICHIA COLI CONTENT OF MYTILUS EDULIS FROM ANALYSIS OF WHOLE TISSUE OR DIGESTIVE TRACT,
University Coll. of Swansea (Wales). Dept. of Botany and Microbiology.
M. M. Al-Jebouri, and D. R. Trollope.
Journal of Applied Bacteriology, Vol 51, No 1, p 135-142, August, 1981. 3 Tab, 16 Ref.

Descriptors: *Mussels, *Mytilus, *Escherichia coli, *Shellfish, Estuarine fisheries, Microbiological studies, *Bacteria, Sewage bacteria, *Pollutant identification, Water pollution effects.

Sensitivity of bacterial counts in shellfish can be improved by using the digestive tracts, rather than whole tissue, for enumeration. Digestive systems of Mytilus edulis contained 3-6 times the number of E. coli as did whole tissue samples from the same waters. Average mean counts in mussels from Mumbles, Swansea, were: total tissue, 136-183; and digestive tract, 401-572. At Oxwich, Gower, counts were: total tissue, 6-7; and digestive tract, 24-40. Three enumeration methods were used: the 1 x 4 ml plate technique, the 4 x 1 ml pour plate technique, and the 2 x 0.2 ml spread plate technique. The 2 x 0.2 ml spread plate method and the 4 x 1 ml method performed equally well for samples from grossly polluted water, but in samples from cleaner water the 2 x 0.2 ml spread plates failed to detect E. coli in 13 batches where bacteria were detected by other methods. The 4 x 1 ml pour plate method gave no false negatives and gave consistently higher counts than the 1 x 4 ml plate technique. Digestive tract inoculum also produced better results than whole tissue samples in the semiquantitative Percentage Clean method when applied to the cleaner samples. Examination of digestive tracts designated 8 of 10 batches unsatisfactory for consumption; examination of the whole tissue, 2 of 10 batches unsatisfactory, and 6 suspicious. There were no differences in results obtained on grossly polluted samples. (Cassar-FRC)
W82-01508

DETERMINATION OF NANOGRAM QUANTITIES OF MERCURY IN WATER WITH A GOLD-PLATED PIEZOELECTRIC CRYSTAL DETECTOR,
New Orleans Univ., L.A. Dept. of Chemistry.
M. H. Ho, G. G. Guilbault, and E. P. Scheide.
Analytics Chimica Acta, Vol 130, No 1, p 141-147, 1981. 4 Fig, 2 Tab, 15 Ref.

Descriptors: *Mercury, *Water analysis, *Pollutant identification, Electrodes, Field tests, On-site investigations.

Mercury in water or biological samples may be determined at the nanogram level (5-100 ng) with a gold-coated piezoelectric crystal, coupled with a direct reduction technique. The method is simple and inexpensive. The detector, free of interferences seen in cold-vapor atomic absorption, is readily portable for field use with batteries. Carrier gas flow rate, configuration of the detector cells, and sample size were critical to sensitivity. Since the detector responds to mass rather than concentration, larger samples increase sensitivity. However, a large sample volume requires a higher flow rate of gas and decreases efficiency of Hg collection on the gold electrode. Of the three configurations tested, the one providing the best contact between gold coating and sample stream is three times more sensitive as another configuration. The detector, with a lifetime of at least 60 cycles, is regenerated by thermal desorption at 170 C in a flow of hot air or nitrogen. (Cassar-FRC)
W82-01509

SOME FACTORS AFFECTING THE DETERMINATION OF PARTICULATE CARBON AND NITROGEN IN RIVER WATER,
Canada Centre for Inland Waters, Burlington (Ontario).
P. H. Whitfield, and J. W. McKinley.
Water Resources Bulletin, Vol 17, No 3, p 381-386, June, 1981. 5 Tab, 4 Ref.

Descriptors: *Sample preservation, *Water sampling, *Nitrogen compounds, *Carbon, Sampling, Rivers, Water analysis, Precision, Particulate matter, Freezing.

Water samples for the determination of particulates nitrogen and carbon should be filtered immediately after collection and the analysis performed as soon as possible. They should not be frozen. Samples collected at 4 rivers in the Vancouver area were subjected to different storage regimes after collection. Samples frozen for 1 week varied from the control by 92-282% in particulate N and 113-338% in particulate C. Samples stored at 5 C varied from the control by 70-139% in particulate N and 87-131% in particulate C. Filtering the samples directly after collection and storing for 1 day (control) or 1 week produced no significant differences between the two groups in most cases. However, for a level or precision greater than 10%, samples should be analyzed immediately. Storage for 1 week at freezing temperatures changed the proportions of the chemical forms of N (nitrate-nitrite, ammonia, dissolved organic N) in 58% of the cases; for storage at 5 C, 42%. (Cassar-FRC)
W82-01532

COMPARISON OF SELECTIVE MEDIA FOR THE ENUMERATION AND IDENTIFICATION OF FECAL STREPTOCOCCI FROM NATURAL SOURCES,
Ontario Ministry of the Environment, Rexdale.
J. E. Pagel, and G. M. Hardy.
Canadian Journal of Microbiology, Vol 26, No 11, p 1320-1327, 1980. 5 Tab, 20 Ref.

Descriptors: *Bacterial analysis, *Streptococcus, *Culture media, *Membrane filters, Agar, *Pollutant identification, Water analysis, Effluents, Wastewater analysis, Filter media, Selective media, Microbiological studies, Bacteria.

The mEnterococcus (mEnt) agar was compared with four other routinely used membrane filtration bacteria selective media and procedures for fecal streptococci recovery on samples of raw sewage, sewage effluent, and combined storm sewer water. Best overall results were obtained with mEnt agar, which gave 92% specificity for enterococci and very good recovery efficiency with low background counts. It was the only media showing appreciable recovery of other fecal streptococci, with 93% of the background colonies being confirmed as fecal streptococci (mostly S. bovis, S. equinus, or S. salivarius). Second in performance was Pfizer selective enterococcus (PSE) agar, with a specificity rate of 96% but lower recovery efficiency and high background counts. The KF agar recovered higher numbers of organisms, but only 81% were fecal streptococci. The Slanetz and Bartley (SB) medium had low specificity. The mE procedure was highly specific but gave low recoveries. A total of 512 colonies was identified from test media. (Cassar-FRC)
W82-01564

AN ESTUARINE AGAR MEDIUM FOR ENUMERATION OF AEROBIC HETEROTROPHIC BACTERIA ASSOCIATED WITH WATER, SEDIMENT, AND SHELLFISH,
Maryland Univ., College Park. Dept. of Microbiology.
R. M. Weiner, D. Hussong, and R. R. Colwell.
Canadian Journal of Microbiology, Vol 26, No 11, p 1366-1369, 1980. 3 Tab, 13 Ref.

Descriptors: *Bacterial analysis, *Agars, *Estuarine environment, Pollutant identification, Bacteria, Aquatic bacteria, Water analysis, Sediment, Oysters, Shellfish, Heterotrophic bacteria, Aerobic bacteria.

An estuarine agar of reduced salt content is recommended for enumerating aerobic, heterotrophic bacteria in samples of water, sediment, and oysters. The final concentration of added salts in the estuarine agar was 9.4% and final pH 7.5, compared with (1) 10.5% and pH 7.2 for estuarine salt water yeast extract agar and (2) no added salts and pH 7.0 for tryptone-glucose-yeast extract agar. Compared with the other agar media, the estuarine agar produced higher bacterial counts and increased taxonomic diversity from all water, sediment, and oyster samples tested. (Cassar-FRC)
W82-01565

EVALUATION OF ULTRAVIOLET SPECTROPHOTOMETRIC DETERMINATION OF NITRATE-NITROGEN IN GLACIAL SNOW, FIRN AND ICE,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Biology.
B. C. Parker, W. J. Thompson, and E. J. Zeller.
Analyst, Vol 106, No 1265, p 898-901, August, 1981. 1 Fig, 1 Tab, 10 Ref.

Descriptors: *Nitrates, *Spectrophotometry, *Firn, Pollutant identification, Water analysis, Glaciers, *Antarctic, Ultraviolet radiation, *Snow, Ice.

The direct ultraviolet spectrophotometric method for determining nitrate-N was applied to samples of South Pole firn core. The correlation coefficient was 0.9818, relative standard deviation 2.2%, and relative error, 3.9% at the 12 microgram per liter nitrate-N level. About 40 determinations per hour are possible. No major interferences were found from calcium chloride, potassium chloride, ammonium chloride, ammonium sulfate, sodium chloride, sodium carbonate, or sodium silicate at levels likely to be found in South Pole snow. High levels of Na could depress the ultraviolet absorbance reading for nitrate-N at 210 nm by 1-2 micrograms. Comparisons with the ultraviolet spectrophotometric-standard addition method and the cadmium reduction-diazotization method produced similar values. However, the cadmium method requires at least twice as much time. Surface snow containing particulates or organic matter cannot be reliably analyzed by this method. (Cassar-FRC)
W82-01572

APPLICATION OF CAPILLARY GAS CHROMATOGRAPHY MASS SPECTROMETRY/COMPUTER TECHNIQUES TO SYNOPTIC SURVEY OF ORGANIC MATERIAL IN BED SEDIMENT,

Geological Survey, Denver, CO.
T. R. Steinheimer, W. E. Pereira, and S. M. Johnson.
Analytica Chimica Acta, Vol 129, p 57-67, August, 1981. 7 Fig, 1 Tab, 20 Ref.

Descriptors: *Organic compounds, *Sediments, Industrial wastes, Monitoring, Water pollution sources, River beds, Streambeds, *Chemical analysis, Gas chromatography.

A synoptic survey is presented so that an overview might be realized of the environmental chemistry active in an area impacted by heavy industrial activity. Organic compounds were sought in a bed sediment sample. Extraction was performed on a Soxhlet apparatus using a freeze-dried sample. The Soxhlet extract was fractionated by silica gel micro-column adsorption chromatography. Separation and identification of the organic compounds was accomplished by capillary gas chromatography/mass spectrometry. Over 50 compounds were identified including saturated hydrocarbons, olefins, aromatic hydrocarbons, alkylated polycyclic aromatic hydrocarbons, and oxygenated compounds such as aldehydes and ketones. These were present as a complex mixture resulting from natural products and pollutants from waste discharges. The deposition and concentration of these materials on the bed sediment was determined by river hydrology and other general river conditions. Many of the pollutants identified are susceptible to bioaccumulation. The redistribution of some of these contaminants into the water column during periods of high flow or other kinds of perturbation argues persuasively for synoptic-survey bed sediment analysis as an indicator of water quality. Additional refinements in the capillary column gas chromatographic portion of the analysis may reveal further organic pollutants of significance to the environment. (Baker-FRC)
W82-01573

PRECONCENTRATION FOR TRACE ELEMENT DETERMINATION IN AQUEOUS SAMPLES,
Denver Univ., CO. Dept. of Chemistry.
D. E. Leyden, and W. Wegscheider.
Analytical Chemistry, Vol 53, No 9, p 1059A-1065A, August, 1981. 55 Ref.

Descriptors: *Sample preparation, *Trace elements, *Separation techniques, Water analysis, Preconcentration, Seawater, Ion exchange, Solvent extraction, Electrodeposition, Evaporation, Adsorption, Chemical precipitation, Reviews, *Pollutant identification.

Methods for preconcentrating trace elements in water are discussed as supplements, rather than alternatives, to modern instrumentation. The simplest method of preconcentrating ions is evaporation from solution. This technique, frequently used with X-ray spectrometry, is not suitable where one ion has a high and variable concentration. Electrodeposition, particularly anodic stripping analysis, has been extremely useful. Few reagents are needed and instrumentation is simple, but deposition is very slow. Electrodeposition from seawater has been more promising than that from freshwater. A widely used preconcentration technique is liquid-liquid extraction using a water-immiscible solvent and an aqueous solution containing a chelating agent. Possible improvements in the extraction technique involve continuous extraction, countercurrent flow, combination with gas-liquid chromatography or ICP-AES, and using an organic phase which readily solidifies upon cooling after extraction. Surface adsorption of metal complexes on activated carbon or C18-bonded silica gel attains concentration factors up to 200. Precipitation in the range of interest is not quantitative but may be useful with coprecipitation agents or carrier ions. Larger concentration factors (about 40,000) are obtained with ion exchange methods. The ion may be eluted for analysis in solution or be analyzed directly on the solid matrix. Many resins are available for this purpose: Chelex 100 is widely used. Ion exchange resins may be used to impregnate paper disks or membranes. Other modifications of ion exchange techniques are foams and gels for one-time use and silylation reactions. Several specialized methods are available for specific ions. (Cassar-FRC)
W82-01574

POLYCHLORINATED BIPHENYLS AND OTHER ORGANIC CHEMICAL RESIDUES IN FISH FROM MAJOR UNITED STATES WATERSHEDS NEAR THE GREAT LAKES, 1978,
Environmental Research Lab.-Duluth, MN.
G. D. Veith, D. W. Kuehl, E. N. Leonard, K. Welch, and G. Pratt.
Pesticides Monitoring Journal, Vol 15, No 1, p 1-8 June, 1981. 3 Fig, 2 Tab, 6 Ref.

Descriptors: *Polychlorinated biphenyls, *Fish, *Pesticides, Water pollution sources, Great Lakes, DDT, Chlordane, Environmental effects, Gas chromatography, Halogenated pesticides, Bioindicators.

Exploratory studies of chemicals in fish were performed on specimens obtained from rivers in Minnesota, Wisconsin, Indiana, Michigan, Ohio, and New York. Twenty-six composite fish samples were analyzed for polychlorinated biphenyls (PCBs) and related organic chemicals. In all samples, PCB mixtures resembling Aroclor 1254 were found, and 77% of the samples included mixtures resembling Aroclor 1242. DDT was a minor contaminant, while hexachlorobenzene was determined in 65% of the samples. Chlorine and components of technical chlordane were found in 38% of the samples. Pentachloroanisole was found in 15 samples, and heptachloronorbornadiene and hexachloronorbornadiene were found only in the Wabash River. Mirex was found only in Lake Ontario fish. While PCB's were found in all samples, the predominant forms were tetra-, penta-, and hexachlorobiphenyl homologs. PCBs containing two or three chlorine atoms were found in 19 of the 26 samples. Major improvements are needed in GLC/MS screening before an adequate number of samples can be evaluated. (Small-FRC)
W82-01583

CONCENTRATING ORGANICS IN WATER FOR BIOLOGICAL TESTING,
Oak Ridge National Lab., TN.
R. L. Jolley.
Environmental Science and Technology, Vol 15, No 8, p 874-880, August, 1981. 2 Tab, 111 Ref.

Descriptors: *Water analysis, *Organic compounds, Reverse osmosis, Vacuum filtration, Ultrafiltration, Solvents, Organic solvents, Activated carbon, Resins, Chromatography, Precipitation.

Various methods are described for concentration of organics in water, each having its own advantages and disadvantages. The choice of method or combination of methods to be used depends on such factors as the volatility of the organic constituent to be tested, the degree of concentration required, and the biological test system to be used. Concentration methods may be divided into two basic categories, concentration and isolation. Concentration processes remove water and leave the dissolved substances behind. Isolation processes remove the organic substances from the water. Concentration techniques include freeze concentration, lyophilization (or freeze-drying), vacuum distillation or evaporation processes, reverse osmosis, and ultrafiltration. Isolation techniques include solvent extraction, use of activated carbon, carbonaceous adsorbents, XAD resins, open-pore polyurethane, ion-exchange chromatography, precipitation, centrifugation, and gas stripping. Combination procedures are often used, to achieve as high a recovery of organics as is possible. Reverse osmosis has been combined with Donnan dialysis, solvent extraction and disorption on XAD-2 resin. Silica gel, cation-exchange resin and anion-exchange resin followed by vacuum distillation is another combination. Critical areas include the possible presence of humic materials binding lower molecular weight organic substances, lack of a representative sample, improper sample preservation and improper concentration procedures. (Baker-FRC)
W82-01591

5B. Sources Of Pollution

MASS TRANSPORT OF SOLUTES IN DUAL-POROSITY MEDIA,
Water Research Centre, Marlow (England).
R. Bibby.
Water Resources Research, Vol 17, No 4, p 1075-1081, August, 1981. 7 Fig, 2 Tab, 18 Ref.

Descriptors: *Solute transport, *Aquifers, *Porous media, Path of pollutants, Fate of pollutants, Chalk aquifer, Model studies, Mathematical models, Diffusion, Groundwater movement.

The mechanism for solute mass transport in aquifers with static water (high porosity but low permeability) is controlled by secondary processes such as molcular diffusion, adsorption, and reaction, rather than by primary processes such as convection and dispersion. An analytical solution for diffusion from a constant concentration boundary has been incorporated into a 2-dimensional mass transport model, which uses the Galerkin method of weighted residuals and isoparametric finite elements to solve the flow and transport equations. The method is used to simulate pollutant movement in the Chalk aquifer, East Kent, England, specifically the discharge of saline water (318,000 tons of chloride) from collieries into the aquifer from 1926 to 1974. The model indicates that 13% of the total mass of chloride had been discharged from the aquifer by 1978, and by 2008, 68.6% will have been discharged. An unusually large number of parameters are required to calibrate this model because the transport of solutes is so slow that field tests or tracer studies are impractical. Calibration is very difficult (especially the determination of dispersivities) unless a large amount of historical data is available on a large-scale pollution event. (Cassar-FRC)
W82-01104

FACTORS AFFECTING RADIONUCLIDE AVAILABILITY TO VEGETABLES GROWN AT LOS ALAMOS,
Los Alamos National Lab., NM.
G. C. White, T. E. Hakonson, and A. J. Ahlquist.
Journal of Environmental Quality, Vol 10, No 3, p 294-299, July/September, 1981. 10 Tab, 18 Ref.

Descriptors: *Plutonium radioisotopes, *Vegetable crops, *Land disposal, Plutonium, Radioisotopes, Cesium, Beans, Squash, *Radioactive waste disposal, Soil contamination, Fertilizers, Path of pollutants.

There is a need for information on transuranic element transfer into human food chains. A field study was conducted to investigate the availability of plutonium-238, plutonium-239, and cesium-137 to zucchini squash and to green bush beans grown under home garden conditions in an area of the Los Alamos National Laboratory used for the disposal of treated radioactive liquid wastes. The effects of tissue type, height above soil, fertilization regime, and food cleansing procedures (for squash) on radionuclide concentrations were analyzed using analysis of variance procedures. Ratios of the concentration of a radionuclide in oven-dried vegetables to dry soil ranged from 0.0004 to 0.116 for the plutonium isotopes and from 0.051 to 0.255 for cesium-137. The plutonium concentration ratios were reduced by 30 percent when the fields were fertilized with steer manure, while cesium-137 concentration ratios were reduced by about 50 percent. The reduction due to fertilization was attributed to a stabilization of the soil surface and to increased potassium concentrations (the latter for Cesium-137 only). The finding that vegetative parts within 20 centimeters of the ground surface were about four times as heavily contaminated as plant parts growing further from the surface indicates that a major source of contamination in these plants was soil on the plant surfaces. Washing of the zucchini plants resulted in removal of about 65 percent of the contamination. The 50-year radiation doses to humans consuming these vegetables would be less than 0.05 mrem, and this would be due almost entirely to cesium-137. (Carroll-FRC)
W82-01109

NITRATE REDUCTION IN AN ORGANIC SOIL-WATER SYSTEM,
Agricultural Research and Education Center, Sanford, FL.
K. R. Reddy, P. D. Sacco, and D. A. Graetz.
Journal of Environmental Quality, Vol 9, No 2, p 283-288, April-June, 1980. 5 Fig, 5 Tab, 20 Ref.

Descriptors: *Nitrates, *Denitrification, *Agricultural runoff, *Organic soils, *Floodwater, Fate of pollutants, Nitrogen, Drainage, Farm wastes, Kinetics, Drainage water, Temperature, Soil columns, Nutrient removal, Water pollution control, Water quality control, Oxygen demand, Infiltration.

The ability of flooded organic soil to counteract the effects of soil denitrification by flood water removal of nitrate-N was examined in three laboratory experiments. Nitrate-N reduction rates in agricultural drainage water and in an underlying organic soil column were studied at nitrate-N levels of 10, 25 and 50 micrograms/ml. Energy source and temperature were varied and labeled nitrate-N was used to distinguish between denitrification and reduction to ammonium-N or organic N. Nitrate-N reduction rates at 28 degrees with no excess flood water and flood water nitrate-N removal rates were both described by first order kinetics. In soil columns treated with high oxygen-demand flood water, most of the nitrate-N disappeared before reaching the underlying soil column with rate constants that increased with temperature. At lower temperatures, more of the flood water nitrate-N diffused deeper into the soil column. These findings show that flooded organic soils may serve as a sink for reducing the nitrate-N levels of agricultural drainage waters and should be considered for use in pollution abatement programs. (Geiger-FRC)
W82-01129

A STUDY OF A METHOD FOR DISPLACING SOIL SOLUTION BY CENTRIFUGING WITH AN IMMISCIBLE LIQUID.
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Land Resources Management.
B. R. Whelan, and N. J. Barrow.
Journal of Environmental Quality, Vol 9, No 2, p 315-319, April-June, 1980. 6 Fig, 4 Tab, 12 Ref.

Descriptors: *Path of pollutants, *Soil solution, *Organic solvents, *Separation techniques, Phosphates, Soil filters, Dispersants, Soil dispersants, Water pollution, Membrane filters, Suspended solids, Soil water, Septic tanks, Septic waste water.

The composition of soil solutions in the study of pollutant movements through soils is of interest because the soil is usually the moving phase. A technique using tetrachloroethylene as displacing liquid for soil solutions is described and compared to both 1,1,1-trichloroethylene and carbon tetrachloride systems. After centrifuging a soil solution with tetrachloroethylene at 170,000 m/sec for 30 min, the solution collects at the top of this dense organic liquid and may be separated by pouring through phase-separating paper. After suspended matter is removed by membrane filtration, the solution may be analyzed. The use of tetrachloroethylene as displacent was considered safer than carbon tetrachloride and did not interfere with subsequent tests for nitrate, as did 1,1,1-trichloroethylene. The present method was recommended for investigations on the movement of water-soluble pollutants through soil and was utilized to study phosphate movement below the discharge from a septic tank. (Geiger-FRC)
W82-01131

THE MOVEMENT OF SALTS FROM SOILS FOLLOWING HEAVY APPLICATION OF FEEDLOT WASTES,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
A. Amoozegar-Fard, W. H. Fuller, and A. W. Warrick.
Journal of Environmental Quality, Vol 9, No 2, p 269-273, April-June, 1980. 5 Tab, 16 Ref.

Descriptors: *Salts, *Manure, *Farm wastes, *Fate of pollutants, Trace elements, Heavy metals, Model studies, Soil water, Soil filters, *Fertilizers, Leachates, Leaching, Magnesium, Minerals, Calcium, Potassium, Chlorides, Sodium.

The movement of salts from soils following heavy application of feedlot manure as fertilizers was studied in relation to water management and the aggregate size of the manure. Air-dried manure was formed into three different sizes, mixed with a sandy loam soil and loaded into a plastic cylinder (15 cm diameter) packed with 10 cm of soil. This model system simulated an application rate of 100 metric tons/ha. Deionized water was passed continually or intermittently through the column, and leachates were collected in one-half of a pore volume increments for the determination of electrical conductivity (EC), pH and other factors. Initial EC's of effluent were up to 8-10 mmho/cm, sufficient to affect growth of most field crops. Heavy irrigation could be applied before planting salt-sensitive crops. The movement of sodium and potassium replaced calcium and magnesium on the soil exchange sites; consequently their movement was delayed, and the rate of irrigation water infiltration was reduced. Chloride movement resembled that of leaching manure alone, while movement of trace elements from the system was insignificant. (Geiger-FRC)
W82-01132

TRANSPORTS IN THE DULUTH-SUPERIOR HARBOR,
Minnesota Univ.-Duluth. Dept. of Physics.
K. R. Stortz, and M. Sydor.
Journal of Great Lakes Research, Vol 6, No 3, p 223-231, 1980. 12 Fig, 3 Tab, 14 Ref.

Descriptors: *Sediment transport, *Ships, *Water quality, *Path of pollutants, Water circulation, Lakes, Suspended sediments, Model studies, Hydrodynamics, Solute transport, *Harbors, *Lake Superior, *Duluth, Minnesota, Seiches.

A hydrodynamic model and a water quality model were developed for simulating the transport of particulates and dissolved material in the Duluth-Superior harbor. An average concentration of 10-15 mg per liter suspended solids was observed in the wake of moving ships. It was estimated that 100,000 kg of sediment is resuspended per passage of a ship. The model predicts that 0.1% of this resuspended material flows into Lake Superior, while the remainder settles to the edges of the shipping channels. At the rate of 1000 large ships visiting the harbor annually, the total amount of resuspended material entering the lake from the harbor is about 100 metric tons per year. Simulation of 200 kg of dissolved pollutant added to the water at the coal dock over an 8 hour period shows that peak concentrations (0.05-0.1% of the initial concentration at the spill site) would reach the Duluth entry in 5-8 days and the Superior entry in 9-17 days, depending on seiche amplitude. The residence time of the contaminant in the harbor is on the order of 30-40 days. (Cassar-FRC)
W82-01136

A CLASSIFICATION AND DESCRIPTION OF SOME NORTHEASTERN ONTARIO LAKES INFLUENCED BY ACID PRECIPITATION,
Laurentian Univ., Sudbury (Ontario). Dept. of Geography.
J. R. Pitblado, W. Keller, and N. I. Conroy.
Journal of Great Lakes Research, Vol 6, No 3, p 247-257, 1980. 7 Fig, 3 Tab, 21 Ref.

Descriptors: *Lake classification, *Acid rain, *Air pollution, Sudbury, *Ontario, Water pollution sources, Path of pollutants, Water quality, Nutrients, Urban runoff, Eutrophication, Metals, Smelting industry, Buffering capacity.

Statistical analysis of water chemistry data (23 variables for 187 lakes in the Sudbury, Ontario, area) showed that most of the chemical variability was attributable to 4 components: nutrient status, buffering status, atmospheric deposition status, and sodium chloride status. Seven distinct groups of lakes were obvious. Group 1 lakes, scattered throughout the study area, were high in nutrients and chlorophyll, reflecting cultural eutrophication. Groups 2 and 3, characteristic, dilute lakes of the Precambrian Shield, had an inverse relationship to the atmospheric deposition status and buffering status dimensions, and were low in smelter-produced ions. They differed in nutrient and chlorophyll a status, Group 2 having the higher values. Groups 4, 5, and 6 reflected the impact of airborne pollutants from smelting operations in Sudbury. Group 5 lakes, closest to the smelters, had high acidity, low buffering capcity, and high concentrations of smelter-related metals. Group 6 lakes showed a lesser impact, and Group 4, limited impact, being more buffered and productive. Group 7, a group of anomalous lakes sharing high pH and high ionic strength, were influenced by limestone bedrock or surficial material as well as urban runoff. (Cassar-FRC)
W82-01145

NONPOINT N RUNOFF FROM AGRICULTURAL WATERSHEDS INTO THE GREAT LAKES,
Department of Agriculture, Summerland (British Columbia).
G. H. Neilsen, J. L. Culley, and D. R. Cameron.
Journal of Great Lakes Research, Vol 6, No 3, p 195-202, 1980. 1 Fig, 6 Tab, 28 Ref.

Descriptors: *Agricultural watersheds, Runoff, *Nitrogen compounds, Path of pollutants, Fertilizers, *Agricultural runoff, Watersheds, Ontario, Nitrates, Ammonium, *Inflow, *Great Lakes, Water pollution control, Nutrients, Soil conservation, Nonpoint pollution sources.

Runoff nitrogen and discharge were continuously monitored in 11 agricultural watersheds in southern Ontario during 1975-1977 as part of the International Joint Commission's Pollution from Land Use Activities Reference Group project. The predominant chemical form of N runoff was nitrate-N (flow weighted concentration means, 0.57-5.62 mg per liter), followed by total Kjeldahl nitrogen (TKN) (0.64-2.37 mg per liter) and average soluble ammonium-N (0.03-0.60 mg per liter). Elevated stream dissolved N concentrations were seen in watersheds with increased areas of row crops, especially corn, extensive tile drainage, and high unit area fertilizer N additions. Elevated TKN occurred in watersheds with extensive impermeable soils, high suspended sediment concentrations, and increased surface runoff. Stream nitrate-N loadings ranged from 2.1 + or - 0.2 to 39.0 + or - 7.6 kg per watershed ha. Some watersheds with intense agricultural activity lost up to 30 kg nitrate-N per ha. Watersheds with extensive woodlot, hay, and pasture gained more nitrate-N from precipitation than was lost in runoff. The most important consideration for reducing soluble N runoff in the agricultural areas under study is efficient management of N fertilizers on the extensive areas of tile-drained corn in the lower Great Lakes basin. Total N runoff could be reduced by a fourth or a third using standard erosion control techniques such as grassed waterways and contour planting. (Cassar-FRC)
W82-01148

MERCURY AND ZINC IN THE SEDIMENTS OF SENECA LAKE, SENECA RIVER, AND KEUKA OUTLET, NEW YORK,
Hobart and William Smith Colleges, Geneva, NY.
T. R. Blackburn, J. C. Cornell, and T. R. Fogg.
Journal of Great Lakes Research, Vol 6, No 1, p 68-75, 1980. 9 Fig, 1 Tab, 10 Ref.

Descriptors: *Mercury, *Zinc, *Lake sediments, Sediments, Heavy metals, Metals, Water pollution sources, Path of pollutants, *Seneca Lake, *New York.

Sediments from Seneca Lake, New York, its principal tributary, and its outlfow were sampled from June 1974 to October 1975. Patterns of Hg and Zn concentrations indicated several probable sources of pollution: municipal sewage outfalls, abandoned industrial plants, and a coal-fired power plant. The total Hg content of the upper 2 cm of lake sediments was estimated at 139 kg Hg using an interpolation technique based on the relationship of heavy

metal content to overlying water depth and the increment of Hg above an assumed unperturbed distribution. Sediment Hg concentrations in the Seneca River were 30-480 micrograms per kg; in two heavily polluted lake sites, up to 3000 and 5500 micrograms per kg, respectively; and as high as 1302 micrograms per kg in Keuka Outlet. Zn levels were 59-157 mg per kg in the lake and up to 633 mg per kg in the outlet. Distribution of Zn paralleled that of Hg. The ratio of Zn to Hg was relatively constant at about 650. (Cassar-FRC)
W82-01151

NUTRIENT LOADING OF SOUTHERN LAKE MICHIGAN BY DRY DEPOSITION OF ATMOSPHERIC AEROSOL,
Governors State Univ., Park Forest South, IL. Coll of Environmental and Applied Sciences.
D. A. Dolske, and H. Sievering.
Journal of Great Lakes Research, Vol 6, No 3, p 184-194, 1980. 3 Fig, 6 Tab, 37 Ref.

Descriptors: *Nutrients, *Aerosols, *Air pollution, Water pollution sources, Path of pollutants, Phosphorus, Nitrogen, Nitrates, *Lake Michigan, Lakes.

Dry deposition accounted for 15% or more of all atmospheric nutrient inputs ot total phosphorus and nitrate-nitrite nitrogen and for 3% of total aerosol mass over southern Lake Michigan. High-volume samplers with cellulose fiber filters were used to collect 42 aerosol samples aboard the USEPA's R/V Roger R. Simons at 87 degrees 0 min west and 42 degrees 0 min north during May to September 1977. Micrometeorological data was documented simultaneously. Aerosol deposition velocity was estimated at 0.65 cm per sec using a diabatic drag coefficient method. Dry decomposition loading for this area of the lake was 150,000-180,000 kg per year for P and 3.5 million to 5.1 million kg per year for N. The aerosol P and N was strongly associated with fine particles, less than 1.0 micrometers in diameter. Nutrients deposited in this form are immediately available to the photosynthetically-active regions: overlake, west shore (Milwaukee), Chicago/Gary, Michigan City, and east shore. (Cassar-FRC)
W82-01152

PCB RESIDUES IN BOTTOM SEDIMENTS COLLECTED FROM THE BAY OF QUINTE, LAKE ONTARIO 1972-1973,
Ontario Ministry of Agriculture and Food, Guelph (Ontario). Pesticide Residue Lab.
R. Frank, R. L. Thomas, M. V. H. Holdrinet, and V. Damiani.
Journal of Great Lakes Research, Vol 6, No 4, p 371-376, 1980. 3 Fig, 1 Tab, 9 Ref.

Descriptors: *Polychlorinated biphenyls, *Lake sediments, Organic compounds, Sampling, Chlorinated hydrocarbons, Sediments, Lake basins, Path of pollutants, Pollutant identification, *Lake Ontario, Bay of Quinte, Water pollution sources.

Surface sediments from 214 locations on a 1 km grid were collected in 1972-1973 from the Bay of Quinte, Lake Ontario, and analyzed for polychlorinated biphenyls (PCB) levels. Mean concentration in sediment for the whole lake was 48 plus or minus 43 ng per g (range, < 2-260). Comparing the mean residue in depositional basins (50 ng per g, range < 2-200) and non-depositional zones (47 ng per g, range < 2-260) showed little difference. The six basins studied varied in mean PCB levels from 33 ng per g in Adolphous to 74 ng per g in Trenton. The high concentrations of PCB near the Trent River and the Moira River implicated these rivers as major sources of PCB to the bay. (Cassar-FRC)
W82-01155

TOXICITY AND BIOACCUMULATION OF ENDRIN AND METHOXYCHLOR IN AQUATIC INVERTEBRATES AND FISH,
Environmental Protection Agency, Duluth, MN.
For primary bibliographic entry see Field 5C.
W82-01160

BIOGEOCHEMICAL INVESTIGATION OF BIG CREEK MARSH, LAKE ERIE, ONTARIO,
National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.
For primary bibliographic entry see Field 2H.
W82-01163

STUDIES ON UNSATURATED ZONE HYDROLOGY AND RADIONUCLIDE MIGRATION AT A SHALLOW-LAND BURIAL SITE,
California Univ., Berkeley, Dept. of Plant and Soil Biology.
R. K. Schulz, E. B. Fowler, E. H. Essington, and W. L. Polzer.
Soil Science, Vol 132, No 1, p 99-103, July, 1981. 3 Fig, 4 Tab.

Descriptors: *Radioactive waste disposal, *Infiltration, *Tritium, Hazards, Radioactive wastes, Water pollution sources, Runoff, Evapotranspiration, Crop production, Hydrology, Maxey Flats, *Kentucky.

Results of an ongoing field study to determine the migration of radionuclides at a shallow-land burial site at Maxey Flats, Kentucky, are reported. The site was closed due to excessive water entry into the trenches and subsequent migration of the radionuclides. The primary mode of water entry into the trench was by percolation through the trench cap. The movement of 3H through the trench cap was upward from the saturation zone. Tritium moved laterally from the trench, and some movement of 60Co was observed. There was no movement of 137Cs, as it was bound to the soil, and 238Pu moved only a few meters from the trench. The site was a low-level waste burial site, and when it was closed in 1977 it had accumulated about 40% of all the commercially generated low-level radioactive waste in the country. Countermeasures to reduce the present problems at the site could include trench recapping, efforts to increase water runoff from the burial site, and different cropping regimes to increase evapotranspiration. (Small-FRC)
W82-01172

AN ANALYTICAL SOLUTION FOR SOLUTE TRANSPORT THROUGH FRACTURED MEDIA WITH MATRIX DIFFUSION,
National Hydrology Research Inst., Ottawa (Ontario).
For primary bibliographic entry see Field 2F.
W82-01179

PLUME DEVELOPMENT USING LAGRANGIAN MARKER METHOD,
Minnesota Univ.-Duluth. Dept. of Physics.
G. J. Oman, and M. Sydor.
Journal of the Waterway, Port, Coastal and Ocean Division, Proceedings of the American Society of Civil Engineers, Vol 107, No WW3, p 131-148, August, 1981. 14 Fig, 21 Ref.

Descriptors: *Plumes, *Mathematical models, *Turbidity currents, Turbidity, *Clays, Runoff, Erosion, *Lake Superior, Wind, Mathematical studies, Water pollution sources, Sediment transport.

The Lagrangian marker method of plume development was used to study the major sources and sinks of red clay turbidity in extreme Western Lake Superior. Simulations of the development of the Nemadji red clay turbidity plume and the long-range transport of runoff water from the Nemadji and St. Louis Rivers were successful. Results were better than those realized by applying mixing and diffusion in finite difference methods. The numerical simulation revealed several things about the transport of pollutants, including the origin of many distinguishable features of the Nemadji red clay. The relative contributions of runoff, resuspension, shore erosion, and runoff from streams could be estimated, and the distribution of contaminated water under different wind conditions was explained. Easterly winds were shown to generate eddy circulations which tend to trap river effluents in the western part of the lake. (Small-FRC)
W82-01182

MONITORING GROUND-WATER CONTAMINATION AT A FLY ASH DISPOSAL SITE USING SURFACE ELECTRICAL RESISTIVITY METHODS,
Wisconsin-Milwaukee Univ. Dept. of Geological Sciences.
R. B. Rogers, and W. F. Kean.
Ground Water, Vol 18, No 5, p 472-478, September-October, 1980. 10 Fig, 11 Ref. OWRT-A-077-WISC(2).

Descriptors: *Fly ash, *Landfills, *Resistivity, Path of pollutants, Leaching, Leachates, Contamination, *Groundwater pollution, Monitoring, Sampling, Electrical properties, Water quality, Waste disposal.

Surface elctrical resistivity measurements effectively located the horizontal and vertical extent of leachate from a fly ash disposal site used by the Wisconsin Electric Power Co. Water samples were collected simultaneously from 33 wells on the landfill site. Laboratory measurements were made on samples from the well borings to determine the changes in resistivity of each lithology as a function of water saturation and the temperature and conductivity of the pore fluid. Profile data were corrected to a common groundwater temperature, compensating for sampling at different seasons of the year. As resistivity decreased, corresponding water samples showed increased contamination. Sampling from March 1978 to May 1979 indicated that the contamination had progressed in a southeasterly direction. This is depicted on a contour map. (Cassar-FRC)
W82-01218

MONITORING LEACHATE IN GROUND WATER BY CORRECTED RESISTIVITY METHODS,
Wisconsin-Milwaukee Univ. Dept. of Geological Sciences.
For primary bibliographic entry see Field 5A.
W82-01219

THE EFFECT OF FLYASH DISPOSAL ON A SHALLOW GROUND-WATER SYSTEM,
Wisconsin Univ.-Milwaukee. Dept. of Geological Sciences.
D. S. Cherkauer.
Ground Water, Vol 18, No 6, p 544-550, November/December, 1980. 1 Tab, 10 Fig, 6 Ref. OWRT-A-077-WISC(4).

Descriptors: *Groundwater, *Landfills, *Metals, *Contamination, *Fly ash, Waste dumps, Aquifers, Toxicity, Leachates, Infiltration, Percolation, Flow, Surface water, Groundwater recharge, Water level, Drawdown.

At a flyash landfill in Wisconsin, dry ash has been placed in contact with a shallow sand and gravel aquifer. The quality of the ground and surface waters has been monitored on a regular basis for several years following construction. Substantial modification of groundwater quality was noted. Sulfate, calcium, and magnesium concentrations increased. However, after eight years, the contamination has spread less than 200 meters from the site in a permeable aquifer. Toxic metals in the flyash appear immobile in the groundwater. The site is located in alkaline sediment upflow from groundwater discharge in a marsh, which impedes spread of contamination. (Titus-FRC)
W82-01220

RADON-222, IN POTABLE WATER SUPPLIES OF NEW ENGLAND,
Maine Univ. at Orono. Dept. of Physics.
C. T. Hess, S. A. Norton, W. F. Brutsaert, R. E. Casparius, and E. G. Coombs.
Journal of the New England Water Works Association, Vol 94, No 2, p 113-128, June, 1980. 5 Fig, 5 Tab, 15 Ref. OWRT-A-045-ME(3), and B-017-ME(2).

Descriptors: *Potable water, *Carcinogens, *Radon, Public health, *Maine, Pollutant identification, Radioactivity, Diseases, Well water, Granite, New England, Metamorphic rocks, Igneous

rocks, Water supply, Path of pollutants, Water pollution effects.

Samples from private and public water supplies in all the counties of Maine were tested for radon-222. Values from northern Aroostock County water were 1000-2000 pCi per liter; southwestern Maine, up to 100,000 pCi per liter; and public utility water, from 22 pCi per liter in a well aerated lake supply to 11,000 pCi in 40 ft deep wells in gravel over granite. Average values (in pCi per liter) found in different types of rock were: granite, 25,000; sillimanite, 12,000; and chlorite, 1,200. Maximum values in well waters were associated with 100-200 ft deep wells, minimum values with shallow wells. Twenty-minute showers in a closed bathroom produced levels of radon in the air as follows: 20 pCi per liter using water of 620 pCi per liter, and 1600 pCi per liter using water of 70,000 pCi per liter. An average reading over 2-3 days was 9-10 pCi per lier in the air. Statistical studies showed that Maine's cancer rates were 122% of the national average. Significant correlations with radon levels were obtained for lung-tracea-bronchus cancer in women, and for lung and reproductive cancer in men. The highest incidences of total and lung cancers were found in counties with the highest calculated radon in water supplies. (Cassar-FRC)
W82-01221

GROUNDWATER CONTAMINATION BY SANITARY LANDFILL LEACHATE AND DOMESTIC WASTEWATER IN CARBONATE TERRAIN: PRINCIPAL SOURCE DIAGNOSIS, CHEMICAL TRANSPORT CHARACTERISTICS AND DESIGN IMPLICATIONS,
Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
J. P. Murray, J. V. Rouse, and A. B. Carpenter.
Water Research, Vol 15, No 6, p 745-757, 1981. 5 Fig, 9 Tab, 41 Ref. OWRT-B-077-MO(5).

Descriptors: *Landfills, *Groundwater pollution, *Tracers, Path of pollutants, Water pollution sources, *Kohl Spring, Missouri, Hydrogen sulfide, Sulfides, Lithium bromide, Solute transport, Septic tanks, Wastewater disposal, Leachates.

Procedures for identification of groundwater pollution sources are illustrated in an investigation of severe pollution in Kohl Spring, Missouri, 1.5 km north of a sanitary landfill. Lithium bromide tracer studies, N:P ratios, chemical response to rainfall variation, bacterial counts, correspondence of dilution ratios for conservative pollutants, and the short interval between initiation of the landfill and the appearance of pollutants in the spring indicated that the landfill was the principal source of pollution, not nearby domestic septic tanks and domestic wastewater stabilization ponds. Geologic structure and the karst nature of the subsurface also were favorable to transport of contaminants from landfill to spring. Pollution was characterized by large amounts of hydrogen sulfide and suspended black metal sulfides. Fish and intruding fauna were killed upon exposure. Water quality in the spring improved rapidly after landfill operations were terminated. (Cassar-FRC)
W82-01223

PREDICTION OF DIFFUSION COEFFICIENTS FROM THE ELECTRICAL CONDUCTANCE OF SOIL,
Department of Agriculture, Lethbridge (Alberta). Research Station.
For primary bibliographic entry see Field 2G.
W82-01224

A COMBINED SALT TRANSPORT-CHEMICAL EQUILIBRIUM MODEL FOR CALCAREOUS AND CYPSIFEROUS SOILS,
Science and Education Administration, Kimberley, ID. Snake River Research Center.
C. W. Robbins, R. J. Wagenet, and J. J. Jurinak.
Soil Science Society of America Journal, Vol 44, No 6, p 1191-1194, November/December, 1980. 3 Fig, 2 Tab, 21 Ref. OWRT-B-148-UTAH(3), 14-34-0001-7195.

Descriptors: *Salts, *Gypsum, *Model studies, Salinity, Calcium carbonate, Cations, Mathematical studies, Chemical precipitation, Lime, Calcium sulfate, Electrical conductivity, Conductivity, Solutes, Bicarbonates, *Saline soils, Sulfates, Carbonates, Soil chemical properties, Chemical reactions, Soil water movement, *Ion transport.

An existing water movement-salt transport model was interfaced with two subroutines, chemical precipitation-dissolution and cation exchange, to provide a computer program which successfully predicted electrical conductivity, soil adsorption ratio, and concentrations of Ca, Mg, Na, K, Cl, sulfate and bicarbonate. The transport model is also useful in the study of relative plant growth and water uptake as affected by soil moisture and salinity. Three model options were available for testing the predictions of salt transport and storage: individual ion transport without soil interaction, precipitation and dissolution of lime and gypsum during transport, and cation exchange and precipitation-dissolution reactions. It was necessary to use both subroutines to obtain results agreeing with observed measurements for a gypsiferous and a nongypsiferous soil irrigated with high, medium and low CaSO4 content waters at two leaching fractions. (Cassar-FRC)
W82-01230

PHENANTHRENE BIODEGRADATION IN FRESHWATER ENVIRONMENTS,
Tennessee Univ., Knoxville. Dept. of Microbiology.
T. W. Sherrill, and G. S. Sayler.
Applied and Environmental Microbiology, Vol 39, No 1, p 172-178, January, 1980. 3 Fig, 6 Tab, 20 Ref. OWRT-B-040-TENN(1).

Descriptors: *Biodegradation, *Hydrocarbons, Polycyclic aromatic hydrocarbons, Temperature effects, Phenanthrene, *Microbial degradation, Microorganisms, Reservoirs, Comparison studies.

An evaluation was made of the potential for significant polycyclic aromatic hydrocarbon (PAH) degradation by the indigenous microbial populations in freshwater environments. Phenanthrene was incubated with water samples from various reservoir systems in Tennessee. Biodegradation was assessed by comparison of total polycyclic aromatic hydrocarbon substrate recovery in degradation flasks relative to sterile control flasks. During 1977 field studies, the mean phenanthrene biodegradation was about 80% after a four week incubation. Within a given habitat, 45% of the total variability in phenanthrene biodegradation was attributable to the physical, chemical, and microbiological site characteristics examined. Polycyclic aromatic hydrocarbon degradation was directly related to the historical environmental pollution of the sampling sites examined, the length of biodegradation assessment, temperature, and the molecular size of the polycyclic aromatic hydrocarbon substrate. (Baker-FRC)
W82-01234

URBAN RUNOFF AND COMBINED SEWER OVERFLOW,
Syearns and Wheeler, Cazenovia, NY.
P. E. Moffa, S. D. Freedman, E. M. Owens, R. Field, and C. Cibik.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 770-776, June, 1981. 82 Ref.

Descriptors: *Urban runoff, *Storm water, *Combined sewer overflows, Water pollution sources, Runoff, Model studies, Storm runoff, Storm overflow sewers, Wastewater treatment, Water pollution control, Water quality, Sewer systems, Reviews, Detention reservoirs, *Literature review.

A review of recent literature on urban runoff and combined sewer overflow describes the results of storm water sampling, hydrology, impact on receiving waters, control of pollution, treatment of storm water, watershed management, and rainfall-runoff models. The most polluted storm waters resulted from commercial land use; these were as high in BOD, COD, and solids, but lower in N and P, than secondary effluent. Some sources of pollution were leaves, deicing salts, automobile exhausts, and street debris. The first flush after dry weather was studied by several authors. A study of combined sewer overflows showed that some needed no abatement and others required treatment. Most streams receiving untreated storm waters showed decreased water quality. Pollution control methods include trapping first-flush waters for later treatment, storage in underground reservoirs or detention basins, and porous pavements. Treatment methods emphasize source control (drainage, erosion control, street sweeping, sewer flushing, and storage), sedimentation, swirl grit separators, and ultra-high rate filtration. Models for studying watershed management are reported. (Cassar-FRC)
W82-01254

PULP AND PAPER INDUSTRY EFFLUENT MANAGEMENT,
National Council for Air and Stream Improvement, Inc., Medford, MA.
For primary bibliographic entry see Field 5D.
W82-01260

SYNTHETIC FUEL EFFLUENTS,
Argonne National Lab., IL.
M. F. Torpy, and E. L. Stover.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 828-831, June, 1981. 33 Ref.

Descriptors: *Synthetic fuels, *Coal gasification, *Oil shale, Water pollution sources, Effluents, *Path of pollutants, Effluents, Gasification, Wastewater treatment, Leachates, Industrial wastewater, Coal liquefaction.

Wastewaters produced by synthetic fuel manufacture from coal gasification and liquefaction and oil shale processing were reviewed. Ammonia and phenol, acting synergistically, were the wastewater constituents toxic to fish. High concentrations of mutagens were present in sludges from treated wastewater. Several papers concerned analytical methods for these effluents. Activated sludge treatment effectively removed base-fraction organics, but not some aromatics and polynuclear hydrocarbons. Ammonia concentrations had to be reduced by dilution or stripping prior to biological treatment of coal gasification wastewaters. Treated effluent was used as a cooling medium, according to a patent. Leachates from spent oil shale piles appeared to be biostimulatory to Lake Powell algae. Methods for treating oil shale retort water included anaerobic digestion, steam stripping, biological treatment, activated carbon adsorption, percolation through spent shale, and evaporation. A study showed that chronic, long term groundwater pollution would be likely in areas of future in situ oil shale development. (Cassar-FRC)
W82-01263

POWER INDUSTRY WASTES,
Tennessee Valley Authority, Norris.
T-Y. J. Chu, and H. Olem.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 831-843, June, 1981. 1 Tab, 215 Ref.

Descriptors: *Electric power industry, *Thermal pollution, *Cooling water, Regulations, Thermal water, Powerplants, Nuclear wastes, Reviews, Radioactive wastes, Wastewater treatment, Water pollution sources, Aquatic life, Water reuse, Fly ash, Entrainment, Industrial wastewater.

Many papers concerning the impact of the power industry and its wastes on water resources were included in a review of recent literature. Environmental regulations relating to the power industry and water quality are summarized in a table. Retrofitting small dams for hydroelectric power production may affect the environment in several ways: disturbance of fish passage, fluctuations in water level and flow and water quality, and sedimentation from dredging. Trace metals released into the environment from fossil-fuel burning plants were studied in aquatic ecosystems, rivers, and the

marine environment. Fly ash piles and slurry threatened groundwater and surface water supplies. One case of ground water contamination by heavy metals was reported. Thermal discharge was the subject of many papers, including a state-of-the-art manual, effectiveness of cooling ponds and lakes, models for predicting heat transfer and aquatic life losses, and ecological effects. Evaluation of a cooling lake fishery showed no harmful effects from the thermal enrichment. Entrainment of zooplankton, phytoplankton, and fish at the cooling water intake was studied and methods were developed to assess the effects. Brackish groundwater, municipal wastewater effluent, and agricultural wastewater were all considered as sources for cooling water. Many wastewater treatment processes were described. Excess heated water from steam-electric plants was used in several ways: a municipal water supply, wastewater treatment, open field irrigation, aquatic facilities, greenhouses, and drying grain. Most of the other waste heat utilizations were reported as cogeneration applications. (Cassar-FRC)
W82-01265

RADIOACTIVE WASTES,
Oak Ridge National Lab., TN.
For primary bibliographic entry see Field 5D.
W82-01268

SOLID WASTES AND WATER QUALITY,
Envirodyne Engineers, Knoxville, TN.
G. R. Brower, and R. Ramkrishnadas.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 896-900, June, 1981. 51 Ref.

Descriptors: *Solid wastes, *Water quality, *Waste disposal, Water pollution sources, Leaching, Monitoring, Fate of pollutants, Regulations, Surface runoff, *Path of pollutants.

The quantity of solid waste, potentially affecting water quality in the United States, estimated at 83.1 million dry metric tons in 1977 and 262.3 million dry metric tons in 1987, has been increased by implementation of environmental legislation such as the Clean Water Act. Contamination or degradation of water supplies has been documented from many sources: septic tank drainfields, rapid infiltration sites, biological treatment wastes discharged into rivers, agricultural and surface runoff, reduced flow from energy development, snow removal dump sites, coal mines, and mercury tailings. Methods of monitoring groundwater and stream pollution from different sources, such as landfills, were reviewed. Treatment and disposal methods and their effects on water quality were described. (Cassar-FRC)
W82-01269

NON-POINT SOURCES,
Browne (F. X.) Associates, Inc., Lansdale, PA.
F. X. Browne.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 901-908, June, 1981. 137 Ref.

Descriptors: *Nonpoint pollution sources, *Literature reviews, Pollution load, Reviews, Nutrients, Runoff, Urban runoff, Sedimentation, Water quality, Watersheds, Model studies, Management planning.

Current research dealing with non-point sources as they affect water pollution treatment is updated in this literature review article. In the area of analysis and characteristics, research has advanced in evaluating the statistical reliability of grab versus composite sampling methods; studies have been conducted of the runoff into undeveloped bays in the Virgin Islands; non-point pollution data were collected on the flat coastal topography of the Maryland eastern slope; and an infiltration-inflow analysis was developed to determine the amount of excess rain and groundwater in a sewer system. Recent studies in the area of water quality effects have included studies of the relationship between precipitation, streamflow and fecal coliform levels in a rural watershed during runoff events; water quality degradation resulting from urban runoff; the spatial and temporal distribution and composition of bacteria in the sediments and overlying waters of the Lynnhaven Estuary in Virginia; and the increasing salinity, turbidity and total hardness of water in the Tigris River resulting from non-point source pollution in Baghdad. Watershed research has emphasized the importance of continued management and monitoring for nonpoint pollution in a developing watershed; the impact of urbanization and recreational development on the hydrologic and nutrient budgets of contrasting watershed systems; and the relationship between geology and vegetation of a watershed as predictors of the nutrient and heavy metal-transporting capacity of its suspended sediment. Research also advanced in the areas of model construction for non-point pollution sources, and in methods for managing these pollution problems. (Baker-FRC)
W82-01270

GROUND WATER,
Geraghty and Miller, Inc., Syosset, NY.
For primary bibliographic entry see Field 2F.
W82-01273

BIOACCUMULATION AND TOXICITY OF HEAVY METALS AND RELATED TRACE ELEMENTS,
O'Brien and Gere Engineers, Inc., Syracuse, NY.
For primary bibliographic entry see Field 5C.
W82-01278

AQUATIC SEDIMENTS,
Clarkson Coll. of Technology, Potsdam, NY.
J. V. DePinto, T. C. Young, and S. C. Martin.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 999-1007, June, 1981. 140 Ref.

Descriptors: *Aquatic soils, *Sediments, *Literature review, Sedimentology, Water pollution sources, Bibliographies, Lakes, Aquatic sediments, Sediment transport, *Path of pollutants.

A 1980 literature review is presented on the topic of aquatic sediments which covers the general areas of analytical and sampling methods, heavy metals, nutrients, biological activity, organics, and modeling. Papers referenced include a review of the use of sediment traps by Bloesch and Burns, and a review and comparison of laboratory and in situ techniques for measurement of sediment oxygen demand. Other papers dealt with the importance of sediment material in eutrophication control, and the importance of aquatic sediments as vehicles for the transport of algal nutrients and toxic materials. Sediments in the Great Lakes which originate from land drainage sources are associated with large quantities of phosphorus, industrial organic chemicals, pesticides, and heavy metals. The relationships between sediments and contaminants in aqueous environments were explored in a compilation of papers. (Small-FRC)
W82-01279

MICROBIOLOGY OF WATER,
Environmental Protection Agency, Cincinnati, OH.
E. E. Geldreich.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1083-1098, June, 1981. 219 Ref.

Descriptors: *Microbiological studies, *Literature review, *Water quality, Bioindicators, Bacteria, Coliforms, Water pollution effects, Path of pollutants.

A review of the literature published during 1980 on the microbiology of water includes sections on microbial indicators of pollution, microbial ecology of water, and the microbiology of river systems, coastal areas and lakes. Studies on indicators defined the characteristics of a good indicator, discussed the coliform standard, and suggested that sulfate-reducing bacteria indicated a fecal origin. The relationships between intestinal microflora and water quality were investigated in cold-blooded animals. Several papers dealt with the natural self-purification processes by which pathogenic and indicator organisms disappear from polluted waters. Microbiology studies of rivers and lakes considered the effects of metabolic activities on the fate of pollutants in aquatic ecosystems. (Small-FRC)
W82-01284

MICROBIOLOGY OF GROUND WATER,
Environmental Protection Agency, Dallas, TX. Region VI.
M. J. Allen.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1107-1109, June, 1981. 23 Ref.

Descriptors: *Groundwater, *Microbiological studies, *Literature review, Bibliographies, Water quality, Public health, Drinking water, Bacteria, Water pollution sources, Groundwater contamination.

A literature review is presented of papers published during 1980 which concerned the microbiology of groundwater. One study isolated coagulase-positive Staphylococcus aureus from over 6% of rural well water specimens. Another study found more than one third of rural water supplies unsatisfactory. Other studies examined groundwater quality and investigated various tracers including hydrogen-sulfide positive E. coli. One study found that even deep aquifers have been contaminated by septic tank leachate. The virus hazard from wastewater sludge application was investigated, and a literature review was published dealing with viruses in groundwater. The effectiveness of disinfectants and surfactants in the control of iron bacteria was evaluated, and the movement of nitrates and phosphates in septic tank effluent was studied and found to be related to microbial activity in the soil. Another study evaluated the effect of sand-clay types and mixtures in the purification of leachfield effluents. (Small-FRC)
W82-01286

MICROBIOLOGY: DETECTION OF BACTERIAL PATHOGENS AND THEIR OCCURRENCE,
Environmental Protection Agency, Cincinnati, OH.
D. J. Reasoner.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1112-1134, June, 1981. 7 Tab, 139 Ref.

Descriptors: *Pathogens, *Bacteria, *Literature review, Bibliographies, Human diseases, Water pollution effects, Enteric bacteria, Salmonella, Microbiological studies.

A literature review is presented of 1980 publications dealing with the occurrence and detection of bacterial pathogens. Information from the references is presented in tabular form. These tables include: occurrence of Salmonella serotypes and related enteric pathogens in warm-blooded animals and in cold-blooded animals; Leptospira in animals; miscellaneous bacterial pathogens and opportunistic pathogens in animals; the occurrence and detection of Enterobacteriaceae in water; the occurrence and detection of Vibrio and Campylobacter in water; and miscellaneous bacterial pathogens and opportunistic pathogens in water. Warm-blooded and cold-blooded animals provide a reservoir of salmonellae transmissible to humans. Enteric pathogens including salmonellae, shigellae, yersiniae, and the chlorela and El Tor vibrios are often waterborne. Legionella organisms are also associated with water habitats. (Small-FRC)
W82-01288

ALUMINUM IN PRECIPITATION, STREAMS, AND SHALLOW GROUNDWATER IN THE NEW JERSEY PINE BARRENS,
Pennsylvania Univ., Philadelphia.
W. W. Budd, A. H. Johnson, J. B. Huss, and R. S. Turner.
Water Resources Research, Vol 17, No 4, p 1179-1183, August, 1981. 5 Fig, 1 Tab, 12 Ref.

Descriptors: *Acidic water, *Acid rain, *Aluminum, Water quality, Air pollution, Humic acids, Fulvic acids, Organic matter, Chelation, Precipitation, Fate of pollutants, Water pollution effects, Streams, McDonalds Branch, Pine Barrens, *New Jersey, Groundwater, Hydrogen ion concentration.

Aluminum appears in waters of the New Jersey Pine Barrens at concentrations of 0-200 micrograms per liter (volume weighted average, 105 micrograms per liter) in precipitation; 100-800 micrograms per liter (volume weighted average, 345 micrograms per liter) in streams; and 0-3000 micrograms per liter (volume weighted average, 468 micrograms per liter, and excluding one very acid well, 329 micrograms per liter) in groundwater. These levels are 10 times greater than in most terrestrial waters, except for the acidified waters of New England and New York. The pH of precipitation in this study averaged 4.0; of groundwater, 4.6; and of streams, 4.1. The total (acid reactive) aluminum deposited in the McDonald's Branch basin was 140 mg per sq meter per year over the study period, May 1978 to May 1980. Stream and groundwater outputs were 149 and 110 mg per sq meters per year, respectively. Increased precipitation, streamflow, and decomposing organic matter caused higher Al inputs and outputs in summer. In streams Al may be transported as an organometallic complex with dissolved organic matter, humic and fulvic acids. Groundwater Al concentrations depend on gibbsite solubility in mineral soils and are pH dependent. (Cassar-FRC)
W82-01297

APPORTIONMENT OF NET RECHARGE IN LANDFILL COVERING LAYER INTO SEPARATE COMPONENTS OF VERTICAL LEAKAGE AND HORIZONTAL SEEPAGE,
Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
For primary bibliographic entry see Field 2G.
W82-01298

WATER CHARACTERISTICS,
Army Construction Engineering Research Lab. (Army), Champaign, IL.
E. D. Smith.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 649-659, June, 1981. 154 Ref.

Descriptors: *Acid precipitation, *Reviews, Water properties, Water analysis, Aquatic plants, Aquatic organisms, *Acid rain, *Environmental effects, Ecological effects.

Recent research on water characteristics is cited in this review article. Acid precipitation has been noted as one of the major environmental problems of the current decade. It poses a serious challenge to national and international bodies to protect water quality. Considerable interest was voiced in 1980 over the causes and effects, prevention and control of acid rain. One study estimated that acid rain was causing an estimated annual $5 billion loss in crop, forest, and aquatic yields, not including the losses due to irreversible damage. Several conferences were held during 1980 on acid rain problems. Groundwater contamination from acid rain was cited as one of the many current and anticipated problems in maintaining a clean and healthful water supply. Acid rain and vegetation interactions were studied in depth, as were the effects of acid precipitation on aquatic organisms. Several researchers reported on analytical techniques. A procedure was developed which may be useful in the quantification of acid rain via isolated precipitation events. The influence of sulfate and soluble metals in summer rains was considered. Natural sources of pollution were shown to affect acid rainfall, as reported for volcanic eruption events. Evaluation of the chemical and physical characteristics of rainfall was reported in the West Indies. Acid precipitation was studied in forest environments. Two efforts assessed the potential for acid rain to leach into the soil. The continuous determination of alkalinity in surface waters, procedures using automated techniques for determining compounds in sea water, techniques for measuring suspended solids, methods for particle analysis, and the development of final effluent monitoring were all investigated. (Baker-FRC)
W82-01305

THE DEPTH OF RAINFALL-RUNOFF-SOIL INTERACTION AS DETERMINED BY P32,
Science and Education Administration, Durant, OK. Southern Plains Watershed and Water Quality Lab.
L. R. Ahuja, A. N. Sharpley, M. Yamamoto, and R. G. Menzel.
Water Resources Research, Vol 17, No 4, p 969-974, August, 1981. 6 Fig, 1 Tab, 16 Ref.

Descriptors: *Phosphorus, *Rainfall-runoff relationships, *Runoff, Fate of pollutants, Tracers, *Soil adsorption capacity, Nutrient removal, Fertilizers, *Agricultural runoff.

The degree of interaction between rainfall, soil, and agricultural chemicals in runoff decreased very rapidly with depth below the surface. P32, a relatively immobile tracer, was applied at the soil surface and at depths of 0.5, 1.0, 1.5, and 2.0 cm in soil boxes. Each box received 6.5 cm per hr of simulated rainfall for 2 separate 30 min periods. Soils were Ruston fine sandy loam Bernow fine sandy loam, and Houston black clay. The average depth of interaction calculated from the data was 0.2-0.3 cm. It was more dependent on the period of rainfall than on the type of soil. The average depths of interaction were used to predict the P concentrations in runoff, which agreed well with observed values. This confirmed that the effective average depth of interaction was valid for P. Transient changes in the effective average depth during a rainfall were then calculated from simultaneous P and P32 concentrations in runoff. The effective average depth increased with time during a rainfall period, more so in the first period than in the second (30 min averages for 3 soil types and 2 storms, 0.207-0.291 cm). (Cassar-FRC)
W82-01318

GEOHYDROLOGIC MODELS OF THE HOUSTON DISTRICT, TEXAS,
Geological Survey, Lawrence, KS.
For primary bibliographic entry see Field 2F.
W82-01335

PHOSPHORUS CONCENTRATION-WATER FLOW INTERACTIONS IN TILE EFFLUENT FROM MANURED LAND,
Cornell Univ., Ithaca, NY. Dept. of Agronomy.
G. W. Hergert, D. R. Bouldin, S. D. Klausner, and P. J. Zwerman.
Journal of Environmental Quality, Vol 10, No 3, p 338-344, July-September, 1981. 10 Fig, 3 Tab, 20 Ref.

Descriptors: *Phosphorus, *Flow characteristics, *Tile drainage, Effluent, *Manure, Fertilizers, Wastewater composition, Flow rates, Nitrate, Chlorides, Perched water table, Water table, Soil solution, Calcium.

During a study of the effects of fertilizing with manure on tile effluent, it was noted that wide variations occurred in the dissolved molybdate reactive phosphorus concentrations both among weekly samples from a given plot and among plots. An irrigation experiment was undertaken to determine the factors causing these variations in phosphorus concentrations in the tile flow. Phosphorus concentrations in tile effluent during drainage events were found to increase with increasing flow, while nitrate and chloride concentrations were inversely related to flow rate. A perched water table was found to exist above high bulk density material with low vertical permeability just below the plow layer. Nitrate/chloride ratios in the tile effluent and in soil samples from various depths indicated that the flow of water to the tile was dominated by downslope movement in the plow layer and by downward movement to the tile in the relatively permeable backfill material above the tile. Phosphorus concentrations were found to be influenced by calcium or salt concentrations in soil solutions and in tile effluent during drainage events. The large increase in phosphorus concentration as the rate of tile flow increases appears to be a consequence of reduced calcium or salt concentration at high flow rates. The impact of manure in these experiments appears to be mainly due to the large amount of phosphorus added, much of which is in inorganic form, which leads to high amounts of labile phosphorus in the soil and which can sustain very high phosphorus concentrations in leaching water. (Carroll-FRC)
W82-01340

FORMATION OF N-NITROSODIMETHYLAMINE DURING TREATMENT OF MUNICIPAL WASTE WATER BY SIMULATED LAND APPLICATION,
Cornell Univ., Ithaca, NY. Dept. of Agronomy.
For primary bibliographic entry see Field 5D.
W82-01343

PREDICTING STREAM SALINITY CHANGES IN SOUTH-WESTERN AUSTRALIA,
Perth Public Works Dept. (Australia).
For primary bibliographic entry see Field 6A.
W82-01350

OBSERVATIONS ON THE HYDROGRAPHY AND INSHORE PLANKTON OF THE BAY OF BENGAL OFF BALASORE,
Ravenshaw Coll., Cuttack (India). Dept. of Zoology.
For primary bibliographic entry see Field 2A.
W82-01362

VOLATILE C1-C7 ORGANIC COMPOUNDS IN SURFACE SEDIMENTS FROM WALVIS BAY,
Woods Hole Oceanographic Institution, MA.
J. K. Whelan, J. M. Hunt, and J. Berman.
Geochimica et Cosmochimica Acta, Vol 44, No 11, p 1767-1785, 1980. 15 Fig, 3 Tab, 51 Ref.

Descriptors: *Organic compounds, *Marine sediments, *Hydrocarbons, Sediments, Sulfur compounds, Organic matter, Volatility, Walvis Bay, Capetown, *South Africa.

Volatile organic compounds were identified in marine sediments collected from Walvis Bay on the African west coast near Capetown, South Africa. Marine organisms, not air transport of material from the adjacent desert or river transport, is believed to be the source of this organic matter. The C1-C7 fraction studied in this work included alkanes (methane, ethane, propane, i- and n-butane, i- and n-pentane, and heptane), alkenes (2-methyl-2-butene, dimethylcyclopentenes, cyclohexene), oxygen containing compounds (2- and 3-methylfuran, 2,5-dimethylfuran, 2- and 3-methylbutanal, and 3-pentanone), sulfur compounds (dimethyl sulfide, thiophene, 2- and 3-methylthiophene) and aromatic compounds (benzene and toluene). Concentrations of most compounds were on the order of a fraction of a nanogram to several nanograms; toluene occurred at the highest levels other than methane. The probable precursors of many of these compounds are marine terpenes, which react in situ at temperatures less than 15 C. The more reactive compounds, furans, keto compounds, and alkenes, were not found in the deeper sections of the 220 cm cores. (Cassar-FRC)
W82-01367

MERCURY AND LEAD CONCENTRATIONS IN SOME SPECIES OF FISH FROM THE TUSCAN COASTS (ITALY),
Pisa Univ. (Italy).
S. S. Buggiani, and C. Vannucchi.
Bulletin of Environmental Contamination and Toxicology, Vol 25, No 1, p 90-92, 1980. 1 Tab, 8 Ref.

Descriptors: *Mercury, *Lead, *Fish populations, Contamination, *Toxicity, Heavy metals, Fish physiology, Tissue analysis, Coastal waters, Estuaries, Environmental effects, Water pollution, Ecosystems, *Tuscan coasts, Italy.

The concentrations of lead and mercury in tissues of marine fish near the Tuscan coasts in 1977 are reported. Composite samples obtained by mixing homogeneous samples from individual fish were analyzed. The data shows that both mercury and lead are consistently present in samples corresponding to the various fishing locations. The maximum absolute values of both metals are found in the same samples. Results suggest potential hazards to human health from small-size fish eaten after only partial removal of the viscera. Seagulls and other components of the food chain should be studied to determine the nature of the source of pollution. The results suggest widespread heavy metal contamination. The fishing areas studied are adjacent to densely populated coasts. (Titus-FRC)
W82-01368

LAND AND STREAM SALINITY IN WESTERN AUSTRALIA,
Perth Public Works Dept. (Australia).
R. M. Hillman.
Agricultural Water Management, Vol 4, No 1-3, p 11-18, 1981. 3 Fig, 3 Ref.

Descriptors: *Saline water, *Salinity, *Catchment areas, Arid lands, Runoff, *Farms, Water quality, Saline soils, Land clearing, Western Australia, *Australia.

Aspects of the problem of dryland salinity and its effects on farmlands and water resources are discussed, with emphasis on Western Australia. Salinity was first recognized as a problem in connection with the supply of boiler water for railway locomotives in 1924. During an agricultural expansion in the 1950's the problem came to the attention of the State and the general public. Today, dryland salinity has resulted in the loss of considerable agricultural land and associated economic losses. Also, only 50% of the divertible surface water remains largely unaffected and still fresh. To arrest and reverse water quality deterioration, clearing controls have been introduced on five important river catchments. Over the past ten years there has been a large research effort aimed at the problem. (Small-FRC)
W82-01374

THE INFLUENCE OF CHEMICAL CONDITIONING AND DEWATERING ON THE DISTRIBUTION OF POLYCHLORINATED BIPHENYLS AND ORGANOCHLORINE INSECTICIDES IN SEWAGE SLUDGES,
Imperial Coll. of Science and Technology, London (England). Dept. of Public Health Engineering.
For primary bibliographic entry see Field 5E.
W82-01387

ATOMIC ABSORPTION SPECTROPHOTOMETRIC STUDIES OF CADMIUM AND ZINC IN COMMERCIAL FERTILISERS, SOILS AND RIVER WATERS,
Aligarh Muslim Univ. (India). Environmental Research Lab.
N. A. Khan, A. Ahmad, A. A. Nomani, and M. Ajmal.
Environmental Pollution, Series B, Vol 2, No 4, p 259-264, 1981. 5 Tab, 18 Ref.

Descriptors: *Fertilizers, *Cadmium, *Zinc, Metals, Heavy metals, Soil analysis, Water analysis, Water pollution sources, Pollutant identification, Rivers, Path of pollutants.

Contamination of soils and waters by cadmium and zinc from commercial fertilizers was determined by atomic absorption spectrometry in soil and water samples collected near Aligarh, India. The concentrations of Cd and Zn, respectively, in fertilizers were 1.2-7.9 and 17-3070 mg per kg; in fertilized productive soils, 0.9-5.9 and 55-95 mg per kg; in barren soils, 0.14-0.06 and 7.5-10 mg per kg; in garden soils, 0.4-0.75 and 7.8-11 mg per kg; and in river water, 0.5-2.3 and 8.5-18.5 mg per liter. (Cassar-FRC)
W82-01388

THE DISTRIBUTION OF MERCURY IN THE SEDIMENTS OF THE PLYM ESTUARY,
Plymouth Polytechnic (England). Dept. of Marine Science.
G. E. Millward, and I. Herbert.
Environmental Pollution, Series B, Vol 2, No 4, p 265-274, 1981. 2 Fig, 5 Tab, 29 Ref.

Descriptors: *Mercury, *Estuaries, *Sediments, Path of pollutants, Plym Estuary, *England, Plymouth Sound, Chemical precipitation, Iron, Manganese, Clay, Organic matter, Rivers, Water pollution sources, Sewage disposal, Metals.

The concentrations of Fe (2800-439,000 micrograms per g), Mn (25-384 micrograms per g), clay (0.03-82.6%), and organic carbon (0.3-8.4%) in surface sediment samples collected in the Plym Estuary, England, correlated well with each other according to statistical analysis. However, Hg concentrations (18-2610 ng per g) were not strongly correlated with any other sediment variables. All data is reported on a dry weight basis. Cluster analysis revealed three geochemical facies. Facies P, upstream with poorly sorted sediments, had higher than expected Hg concentrations (208 ng per g compared with the average for English soils, 60 ng per g) probably as a result of the close proximity to a sewage disposal works outfall. Facies Q, further downstream where water is more saline, had 234 ng Hg per g, only a 16% increase over that of Facies P, suggesting a loss of Hg to Plymouth Sound. Facies R consisted of contaminated sediments (2060 ng per g) associated with sewage effluent disposal. (Cassar-FRC)
W82-01390

CREAMS: A FIELD-SCALE MODEL FOR CHEMICALS, RUNOFF, AND EROSION FROM AGRICULTURAL MANAGEMENT SYSTEMS,
Science and Education Administration, Washington, DC.
Conservation Research Report No 26, May, 1980. 650 p, 147 Fig, 174 Tab, 591 Ref.

Descriptors: *Nonpoint pollution sources, *Model studies, *Erosion, *Agricultural runoff, Agricultural chemicals, Sediment transport, Soil management, Mathematical models, Pesticides, Nutrients.

A mathematical model, CREAMS, was developed to evaluate nonpoint source pollution from field-sized areas under various management practices for selecting Best Management Practices to reduce nonpoint pollution to acceptable levels. CREAMS consists of three components: hydrology, erosion/sedimentation, and chemistry. In order to develop this model quickly, existing physically based models, or those that could readily be modified and improved, were assembled into a package to estimate runoff, sediment, plant nutrient, and pesticide movement in a field. The CREAMS model was developed using units common for the individual components, and therefore, contains mixed or customary units. The purpose of this publication is to provide a complete package for potential users of the model. It is divided into three main divisions. Volume I, model documentation, presents the concepts of model components. Volume II, user manual, provides information on selection of parameter values and model operation. Volume III, supporting documentation, provides the user additional information to obtain parameter values. Results of sensitivity analysis for each component are included in the publication to indicate effects of errors in parameter estimation. (See W82-01402 thru W82-01414) (Moore-SRC)
W82-01401

EROSIVITY 'R' FOR INDIVIDUAL DESIGN STORMS,
Science and Education Administration, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2J.
W82-01403

ENRICHMENT RATIOS FOR WATER QUALITY MODELING,
Science and Education Administration, Durant, OK. Water Quality Management Lab.
For primary bibliographic entry see Field 2J.
W82-01410

NITRATE PRODUCTION, UPTAKE, AND LEACHING,
Science and Education Administration, Durant, OK. Southern Plains Watershed and Water Quality Management Lab.
S. J. Smith, D. E. Kissel, and J. R. Williams.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 493-508, 5 Fig, 6 Tab, 37 Ref.

Descriptors: *Nitrates, *Soil chemistry, *Leaching, *Mineralization, *Fertilizers, *Nonpoint pollution sources, Agriculture, Soil water, Soil temperature, Watersheds, Return flow.

Nitrate in watershed soils is derived mainly from soil organic matter and applied N fertilizer. The behavior of nitrate in watershed soils is complex, and exact prediction of its fate is neither possible nor practical. A simple, abbreviated way for predicting actual amounts of nitrate produced under field conditions was developed, along with different options for assessing the fate of the nitrate. Prediction is on the basis of the soil nitrogen mineralization potential, N sub o, which may be considered as the quantity of soil organic N that is susceptible to mineralization according to first-order kinetics. N sub o can be determined conveniently based on oxidative release of NH4-N from soil organic matter using acid permanganate. Measurements are made for the plow layer (0-15 cm) and a subsurface layer (15-60 cm). For mineralization intervals longer than a day the integrated expression N = N sub 0 (1 - e super-kt) M may be used where N represents the mineralized N; N sub o, the mineralization potential; K, the temperature-adjusted rate constant; t, the time; and M, the soil water content expressed as a percentage of field capacity. The options for assessing the fate of soil and fertilizer-derived nitrate allow for the use of different types and amounts of available input data. One option is based on a water use/dry matter simulation, while the other option is based on the normal probability curve adjusted for water stress. The amount of nitrate available for leaching represents accumulated soil nitrate production plus fertilizer-derived nitrate, minus that taken up by the crop. Both return flow and vertical leaching losses can be calculated on the basis of the nitrate concentration in the root zone and the amount of water percolating through the zone. (See also W82-01401) (Moore-SRC)
W82-01411

ESTIMATING SOLUBLE (PO4-P) AND LABILE PHOSPHORUS IN RUNOFF FROM CROPLANDS,
Science and Education Administration, Oxford, MS. Sedimentation Lab.
L. L. McDowell, J. D. Schreiber, and H. B. Pionke.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 509-533, 7 Fig, 6 Tab, 47 Ref.

Descriptors: *Phosphorus, *Agricultural runoff, *Soil chemistry, *Nutrients, *Nonpoint pollution sources, Mathematical studies, Vegetation, Storm runoff.

Soil P intensity values appear useful for estimating potentially soluble PO4-P in runoff from croplands. Intensity values measured from PO4-P sorption-desorption isotherms and water extracts of soils were used to estimate the annual discharge weighted soluble PO4-P concentrations from plots and watersheds differing greatly in soils, area, fertility, crops, and management. Equilibrium phosphorus concentration (EPC) values better estimated PO4-P in runoff, even when PO4-P from crop residues was an important source. Soil EPC values derived from sorption-desorption isotherms are recommended for estimating the annual discharge weighted PO4-P concentration in runoff. Soil labile P also can be determined from the isotherm, but with a greater uncertainty. simpler tests, such as water-extractable PO4-P and plant available P, can be used to estimate the EPC and the soil labile

P, respectively. They must be tested and verified for application to an area, however. PO4-P concentrations measured in runoff may vary considerably from storm to storm. Crop residues; fertilizers, depending on method of incorporation and time of runoff after application; and possible leaching from green plants can contribute significant and variable quantities of soluble PO4-P. (See also W82-01401) (Moore-SRC)
W82-01412

SOLUBLE N AND P CONCENTRATIONS IN SURFACE RUNOFF WATER,
Science and Education Administration, Morris, MN. North Central Soil Conservation Research Lab.
D. R. Timmons, and R. F. Holt.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 534-543, 5 Tab, 20 Ref.

Descriptors: *Surface runoff, *Nutrients, *Nitrogen, *Phosphorus, *Agricultural runoff, Leaching, Vegetation, Fertilizers, Precipitation, Tillage, Erosion control.

The loss of soluble nutrients in surface runoff for a given runoff event is a function of runoff water volume and soluble nutrient concentration. Since existing values for extraction coefficients are limited, flow weighted concentrations were compared to standard treatments for evaluating the effects of various factors on soluble nutrient concentrations. Soluble N and P concentrations in runoff water result from the interactions of factors which include precipitation, vegetation, fertilizer, tillage, plant residue, and soil. Soluble nutrients can be influenced by the type of vegetation, the stage of physiological development, and the climatic factors preceding the runoff event. The leaching of vegetation by precipitation or runoff is a mechanism that contributes nutrients to surface runoff. The concentrations of soluble N and P in surface runoff water will be influenced by: rate of fertilizer application; method of application; form of fertilizer; time of application; and precipitation after fertilization. The different tillage systems have a direct effect on incorporation of fertilizer and on the plant residue remaining on the surface. As plant residues left on the soil surface to decrease soil erosion are subject to leaching by precipitation or runoff water or both, they will tend to increase soluble nutrient concentrations, as compared to conventional tillage. (See also W82-01401) (Moore-SRC)
W82-01413

PESTICIDE CONCENTRATIONS IN AGRICULTURAL RUNOFF: AVAILABLE DATA AND AN APPROXIMATION FORMULA,
Science and Education Administration, Stoneville, MS. Delta States Agricultural Research Center.
R. D. Wauchope, and R. A. Leonard.
In: CREAMS: A Field-Scale Model for Chemicals, Runoff, and Erosion from Agricultural Management Systems, Conservation Research Report Number 26, May, 1980. p 544-559, 3 Fig, 2 Tab, 33 Ref.

Descriptors: *Pesticides, *Agricultural runoff, *Pesticide kinetics, *Nonpoint pollution sources, Pesticide residues, Surface runoff, Mathematical studies, Subsoil, Soil surface.

Major factors affecting runoff losses of pesticides include: physical and chemical properties of the formulated pesticide; application rate; location of application residue (foilage, soil surface; soil subsurface); and time elapsed between application and runoff storms. Studies have shown that runoff concentrations are roughly proportional to application rate, all other factors being equal. Regardless of pesticide or site, runoff experiments usually show that runoff concentrations decline drastically as the time elapsed between application and runoff increases. Typically, runoff concentrations decrease by a factor of two for every 2-7 days of delay. When pesticides applied as simple aqueous solutions reach their target and dry, the resultant residue should have properties similar to the pure chemical. Many insoluble pesticides are sprayed adsorbed onto solid granules or in nonpolar solvents or emulsions. This will drastically affect the availability of a pesticide for washoff, even after drying. Application of highly soluble pesticides to foilage results in greater runoff concentrations than applications to bare soil. Some pesticides are applied incorporated into subsurface soil, which leads to low runoff concentrations. All of these factors are combined into a rough mathematical formula containing two empirical constants, which are calibrated using selected data on 373 runoff events from the literature. (See also W82-01401) (Moore-SRC)
W82-01414

THE STRINGFELLOW INDUSTRIAL WASTE DISPOSAL SITE: A TECHNICAL ASSESSMENT OF ENVIRONMENTAL IMPACT,
California Dept. of Health Services, Berkely. Hazardous Materials Lab.
R. D. Stephens.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 15-20, 1 Fig, 2 Tab, 12 Ref.

Descriptors: *Waste disposal, *Land disposal, *Industrial wastes, *Floodng, *Soil contamination, Storm runoff, Pollutants, Inorganic compounds, Metals, DDT, Leachates, Deposition, Chromium, Environmental effects, Riverside, *California, Stringfellow Quarry.

The Stringfellow Quarry industrial waste site near Riverside, California, was authorized to accept Class I wastes from 1955 to 1972. Other wastes could be accepted only with specific approval of the Regional Water Quality Control Board. Waste disposal records were incomplete, so that, when two incidents of flooding and runoff from heavy storms occurred, it was not known what pollutants may have been washed out. In the second incident approximately 1 million gallons of polluted liquid was discharged into Pyrite Wash. Liquid, surface, shallow subsurface, and vegetation samples were taken within the disposal site, and the surrounding canyon, and along Pyrite Wash for analysis for metals, anions, and organic compounds. The on-site liquid samples were homogeneous for the major inorganic constituents. The off-site samples showed that all the metals except manganese were attenuated from the leachate, with chromium being lost most rapidly. The primary organic constituent was DDT, and most of it remained as a surface layer in the disposal site. Some had migrated away from the site, and levels of 1 ppm were found some distance downstream from the site. (Brambley-SRC)
W82-01415

CASE STUDIES ON THE MIGRATION OF POLLUTANTS IN GROUND WATER,
State Univ. of New York Coll. at Oswego.
R. J. Scrudato, R. Schneider, R. Hinrichs, and P. Goliber.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC., Environmental Protection Agency Report, (1980). p 71-77, 6 Fig, 3 Tab, 6 Ref.

Descriptors: *Groundwater movement, *Groundwater pollution, *Waste disposal, *Land disposal, *Industrial wastes, Hazardous materials, Chemical analysis, Monitoring, *Oswego County, New York, Lake Ontario, Metals, Heavy metals, Bromine, Economic aspects, Case studies.

There are 22 hazardous waste disposal sites in Oswego County, New York, ten of which contain 55 gal barrels of industrial waste distributed by a defunct industrial waste disposal firm. Three of the sites contain more than 75% of the wastes and they also pose the greatest direct threat to surface and groundwater systems. After a preliminary survey of all the sites a drilling program was started. To date 49 auger holes have been completed at 5 sites. Drilling logs are being maintained, ground water migration is being monitored, and organic and inorganic analysis of the water are being conducted. Two sites containing 8,000 and 15,000 barrels of waste, respectively, have been subject to detailed geological and hydrological study. The first site is on the top of a hill, in a ground water recharge area, with ground water movement to the south-southeast, towards residences. The groundwater contains elevated levels of manganese, iron, zinc, and bromine. The second site is situated between two creeks, 1500 ft south of Lake Ontario. Ground and surface waters move toward the lake, and the groundwater contains elevated concentrations of manganese, iron, zinc, nickel, lead, and bromine. Although the threat to the local water resources is recognized, little remedial work has been done, due to lack of planning and funding. Groundwater monitoring and analysis are continuing. (Brambley-SRC)
W82-01424

GEOLOGICAL STUDIES OF INDUSTRIALLY-RELATED CONTAMINATION: SOIL AND GROUND WATER INVESTIGATIONS,
Metcalf and Eddy, Inc., Boston, MA.
D. H. Bruehl, N. K. Chung, and W. F. Diesl.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report, (1980). p 78-84, 8 Fig, 2 Tab.

Descriptors: *Waste disposal, *Land disposal, *Groundwater pollution, *Paint industry, *Water pollution control, Chromium, Organic solvents, Soil contamination, Leachates, Aquifers, Chlorinated hydrocarbons, Phthalates.

A case history of an actual hazardous waste site investigation is presented to detail the phases leading to closure of a site that is posing a hazard to resources. The dump site is about 1 acre in size in a broad limestone valley, and contains paint wastes and organic solvents. It is poorly defined and covered with dense vegetation. After initial reconnaissance and data collection a baseline was drawn across the suspected site and 51 surface soil samples were taken on a grid pattern. Chromium concentrations in soil samples ranged from 20 - 280,000 mg/kg. Test pits were dug by backhoe to delineate the extent of the wastes. Organic waste, containing trichloroethylene, tetrachloroethane and dibutylphthalate, occurred primarily in a lens within the chromium waste. Laboratory extraction procedures showed that most of the chromium was non-extractable. Ground water analyses showed contamination by chromium, oil and grease, and total organic carbon. Two wells in the contaminated ground water plume contained high concentrations of 5 organic compounds on the EPA Priority Pollutant list. Of the four rehabilitation possibilities - chemical fixation with off-site or on-site disposal, on-site or off-site disposal in an approved hazardous waste landfill - the last was chosen. There was no way to fix the pollutants effectively, and, although more expensive, off-site disposal will afford greater protection to the limestone aquifer and will be quicker to implement. Sampling must be conducted to ensure that all contaminated material is removed, and a clay cap installed on the bedrock to prevent infiltration. (Brambley-SRC).
W82-01425

LOVE CANAL: CHEMICAL CONTAMINATION AND MIGRATION,
New York State Dept. of Health, Albany. Div. of Labs. and Research.
C. S. Kim, R. Narang, A. Richards, K. Aldous, and P. O'Keefe.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 212-219, 9 Fig, 2 Tab, 8 Ref.

Descriptors: *Love Canal, New York, *Waste dumps, *Chlorinated hydrocarbons, *Dioxin, *Groundwater pollution, Storm sewers, Hazardous materials, Groundwater movement, Leachates, Soil contamination, Outfall, Sumps, Dusts, *Path of pollutants.

A brief history of Love Canal, New York, is presented, from its construction in 1890, its use as a

waste dump from 1942-1953, sale in 1953, construction of residences and a school from 1954 to the early 1970's, to the complaints and fencing of the canal in 1978. The air, soil, water and non-water-soluble liquids were analyzed; all indicated contamination by a large number of organic compounds, including many chlorinated hydrocarbons. Water, leachate, soil and sediment samples contained dioxin at concentratons of 1.4 - 312 ppt. The major swale crossing the canal site and the fill around utility lines were demonstrated not to be the main pollutant pathway, but that the storm sewers were. They received the contaminated water pumped by the sump pumps in the basements of the houses closest to the canal. Two major contaminant entry points were located, and the two outfalls of the storm sewer system were contaminated. Because of the complex mixture of chemicals the hazard posed by any one is difficult to assess. Evidence of through-ground transport of chemical wastes appears to be limited to the first ring of homes, but some canal soils have been moved for use as fill. Windborne dusts and vapors contributed to the wider distribution of chemicals. (Brambley-SRC)
W82-01436

LABORATORY PROCEDURE FOR ESTIMATING RESIDUE DYNAMICS OF XENOBIOTIC CONTAMINANTS IN A FRESHWATER FOOD CHAIN,
Columbia National Fisheries Research Lab., MD.
B. T. Johnson.
Technical Papers of the U.S. Fish and Wildlife Service, No 103, 1980. 18 p, 1 Fig, 16 Ref.

Descriptors: *Model studies, *Food chains, *Bioaccumulation, *Biodegradation, *Pollutants, Microorganisms, Daphnia, Organic compounds, Bluegills, Water pollution, Fish.

A model food chain provides a simple means for estimating, under laboratory conditions, the movement of a synthetic organic chemical contaminant. This laboratory method is designed to investigate the accumulation, transfer, degradation, and elimination (residue dynamics) of xenobiotic chemicals in a simple freshwater food chain representing three aquatic trophic levels: microorganisms (yeast, protozoa, bacteria, or algae); filter-feeder (daphnid); and fish (bluegill). Accumulation data may potentially be drawn from five routes within the model system: water to microorganisms, microorganisms to daphnids, water to daphnids, daphnids to fish, and water to fish. Also, the simultaneous use of different water and food combinations produces a number of possible permutations for the evaluation of residue dynamics. The three trophic levels of the model are never tested together in the same chamber because of the difficulties in controlling natural predator-prey relations between organisms of different trophic levels over extended periods. A flow-through diluter-system, carbon-14 labeled contaminants, gas and thin-layer chromatography, autoradiography, and liquid scintillation spectrometry are used in making residue determinations. Accumulation factors and various index values are developed for measuring and estimating potential accumulation of xenobiotic contaminants by aquatic organisms. The laboratory procedure is economical, simple, reproducible, and ecologically relevant. (Moore-SRC)
W82-01443

MERCURY IN THE MUSCLE TISSUE OF FISH FROM THREE NORTHERN MAINE LAKES,
Maine Univ. at Orono; and Columbia National Fisheries Research Lab.
J. J. Akielaszek, and T. A. Haines.
Bulletin of Environmental Contamination and Toxicology, Vol 27, No 2, p 201-208, August, 1981. 1 Fig, 4 Tab, 15 Ref.

Descriptors: *Mercury, *Trout, *Wilderness areas, *Lakes, Fish, Water pollution effects, Air pollution effects, Oligotrophic lakes, Trophic level, *Maine, Chemical analysis, Path of pollutants.

Levels of mercury were measured in the muscle tissue of brook trout (Salvelinus fontinalis) and lake trout (S. namaycush) from three lakes in northern Maine: Eagle Lake, Cliff Lake, and St. Froid Lake. Some researches have reported higher levels of mercury in trout from oligotrophic waters than in trout from eutrophic waters in unpolluted areas. This study also indicated that high mercury concentrations appear to be characteristic of certain fish in certain locations in the Allagash Wilderness Waterway and other areas in northern Maine. Mercury concentrations in lake trout, burbot, and lake whitefish were higher than might be expected. The high mercury content resulted from a combination of factors, including trophic status of the fish, increased uptake of fish mercury under oligotrophic conditions, and some source of mercury input into these aquatic systems. A likely source of mercury in wilderness Maine is contaminated precipitation. (Small-FRC)
W82-01459

A STOCHASTIC APPROACH FOR DESCRIBING CONVECTIVE-DISPERSIVE SOLUTE TRANSPORT IN SATURATED POROUS MEDIA,
Florida Univ., Gainesville, Dept. of Statistics.
P. V. Rao, K. M. Portier, and P. S. C. Rao.
Water Resources Research, Vol 17, No 4, p 963-968, August, 1981. 2 Fig, 14 Ref.

Descriptors: *Solute transport, *Porous media, *Saturated flow, Path of pollutants, Model studies, Mathematical models, Stochastic process.

A stochastic approach is presented for describing convective-dispersive solute transport during steady water flow in homogeneous, water-saturated porous media. The movement of a single solute particle is considered as homogeneous Brownian motion with a positive drift. An integral expression is derived for the form of the expected solute concentration by combining the Brownian motion assumption with the probability density function for the first passage time of a specific solute particle at a given position with the rate of entry of solute particles into the porous medium. This expression leads to known solutions for two cases where analytical solutions exist (instantaneous release and continuous input). The method is also applied to a case of periodic solute input. This method eliminates the need to solve a set of partial differential equations for each set of initial and boundary conditions and allows for estimating the confidence intervals on the drift (velocity) and diffusion (dispersion) coefficients. (Cassar-FRC)
W82-01461

ESTIMATION OF IMPERVIOUS-AREA WASHOFF PARAMETERS,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 4C.
W82-01465

RIVER BASIN HYDROSALINITY MODELING,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2K.
W82-01469

NITROGEN LEACHING AS INFLUENCED BY NITROGEN MANAGEMENT AND SUPPLEMENT IRRIGATION LEVEL,
Scientific and Education Administration, Morris, MN. North Central Soil Conservation Research Lab.
D. R. Timmons, and A. S. Dylla.
Journal of Environmental Quality, Vol, 10, No 3, p 421-426, July-September, 1981. 5 Tab, 25 Ref.

Descriptors: *Nitrogen, *Irrigation effects, *Leaching, Nitrogen compounds, Soil types, *Fertilizers, Crop production, Corn, Nitrites, Percolation, Lysimeters, Soil water, Farm management, Nutrients.

The increased use of fertilization and supplemental irrigation on sandy soils in the northwest corn belt area has created a need for information on management practices which can be used to minimize nitrate-nitrogen leaching losses. Nitrogen was applied in droughty Estherville sandy loam soil either as granules broadcast and disked in before planting or in liquid form through the irrigation system four times during the growing season. Supplemental irrigation was applied either as a partial replenishment (2.5 cm) or as a full replenishment (5 cm) irrigation each time the available soil water reached 50% depletion. Annual soil water percolation from spring thaw to autumn freeze averaged about 7.1 cm for nonirrigated corn, 11.2 cm for 2.5-cm irrigated corn, and 18.0 cm for 5-cm irrigated corn during the 5-year period studied. Average annual nitrate-nitrogen losses from the intensely managed corn systems which were both fertilized and irrigated ranged from 17 to 62% higher than such losses from fertilized, nonirrigated corn. The 5-year average nitrate-nitrogen losses for the 5-cm irrigation level were about 31% greater than those for the 2.5-cm irrigation level. The nitrogen application method had no effect on corn yields, but the use of liquid rather than granular nitrogen fertilizer reduced nitrate-nitrogen leaching losses about 11% for the 5-cm irrigation level and not at all for the 2.5-cm irrigation level. A combination of partial replenishment irrigation with period application of fertilizer nitrogen in the irrigation water should sustain high corn yields and help to minimize soil water percolation and nitrate-nitrogen leaching losses. (Carroll-FRC)
W82-01472

THE RELEASE OF SOIL PHOSPHOROUS TO RUNOFF IN RELATION TO THE KINETICS OF DESORPTION,
Scientific and Educational Administration, Durant, OK. Southern Plains Watershed and Water Quality Lab.
A. N. Sharpley, L. R. Ahuja, and R. G. Menzel.
Journal of Environmental Quality, Vol 10, No 3, p 386-391, July-September, 1981. 5 Fig, 4 Tab, 21 Ref.

Descriptors: *Phosphorus, *Surface runoff, *Soil properties, Soil aggregates, Fertilizers, Phosphates, Mathematical models, Pesticide kinetics, *Runoff.

Very little is known about the kinetics of phosphorus release during a rainfall or about the extent and dynamics of the interacting layer of surface soil. This study investigated the release of phosphorus from surface soil to runoff water under simulated rainfall conditions for five soils at several rates of fertilizer phorphorus application. An empirical model had previously been proposed for the description of the kinetics of phosphorus desorption in water as a function of rate of phosphorus addition to soil and of water/soil ratio for five different soils. This model was used to describe the release of phosphorus to runoff water from soil under simulated rainfall. Both the concentration of soluble phosphorus in runoff during an event and mean values for successive events were adequately described by this simplified kinetic model. The logarithm of soluble phosphorus concentration was found to decrease linearly during an event as the logarithm of time increased. Mean soluble phosphorus concentrations of individual runoff events increased linearly with amount of desorbable phosphorus in the surface soil, while a power function related to water/soil ratio could be used to explain the effect of increased rain intensity on concentrations. The average depth of runoff-surface soil interaction calculated from the data using the kinetic model ranged from 1.5 to 3.0 millimeters for the five soils and was significantly related to the degree of soil aggregation. There was close agreement between these depth values and those determined in early earlier studies using phosphorus-32 as a tracer. The depth of interaction increased with increase in soil slope, kinetic energy of the raindrops, and to a lesser extent, rainfall intensity. Modeling of soluble phosphorus loading in runoff could be improved by using this kinetic model. (Carroll-FRC)
W82-01477

EFFECTS OF DAIRY MANURE ON PHOSPHORUS CONCENTRATIONS AND LOSSES IN TILE EFFLUENT,
Cornell Univ., Ithaca, NY. Dept. of Agronomy.
G. W. Hergert, S. D. Klausner, D. R. Bouldin, and P. J. Zwerman.

Journal of Environmental Quality, Vol 10, No 3, p 345-349, July-September, 1981. 2 Fig, 7 Tab, 19 Ref.

Descriptors: *Phosphorus, *Tile drainage, *Manure, Animal wastes, *Dairy industry, Wastewater composition, Fertilizers, Leachage, Drainage, Water quality, Surface runoff.

In the Northeastern United States, large areas of farmland are tile drained due to poor internal drainage. The phosphorus content of tile effluent is an important consideration because a major portion of the phosphorus in these effluents is dissolved and dissolved phosphorus controls phytoplankton activity in lakes in this region. The dissolved phosphorus concentrations and losses in effluent from a tile-drained silt loam during three consecutive years of dairy manure applications were compared with those for the four years prior to manuring. The plots had received fertilizer phosphorus in the years prior to manuring and received applications of either 35 or 200 wet metric tons of manure per hectare per year during manuring. Over 95% of the effluent samples prior to manuring contained dissolved molybdate reactive phosphorus (DMRP) concentrations of less than 30 parts per billion (ppb). During the three years when manure was applied, 92% of the effluent samples from plots receiving 35 ton applications contained less than 30 ppb of phosphorus, while only 53% of the plots receiving 200 ton applications did so. The flow-weighted DMRP concentrations in the tile effluent were 116, 441, and 97 ppb for the 200 ton applications and 22, 10, and 9 ppb for the 35 ton applications, respectively, during the 3 years the manure was applied. Although the tile flow accounted for about 40% of the drainage water lost from the plots, the phosphorus contents of the tile flow amounted to 10% of the total dissolved phosphorus losses in surface runoff. These results demonstrate that annual applications of 200 metric tons of manure per hectare per year have an undesirable effect on dissolved phosphorus in tile drain effluent and provide far more phosphorus and nitrogen than corn crops can use. (Carroll-FRC)
W82-01479

THE ROLE OF ATMOSPHERIC DEPOSITION IN AN EASTERN U.S. DECIDUOUS FOREST,
Oak Ridge National Lab., TN. Environmental Sciences Div.
S. E. Lindberg, and R. C. Harriss.
Water, Air, and Soil Pollution, Vol 16, No 1, p 13-31, July, 1981. 6 Fig, 6 Tab, 59 Ref.

Descriptors: *Heavy metals, *Deposition, *Deciduous forests, *Air pollution effects, Sulfates, Solubility, Toxicity, Rainfall, Environmental effects.

Deposition rates and processes were investigated for Mn, Zn, Cd, Pb, and SO4(2-) in a forest canopy and its underlying soils. The following were determined: aerosol composition and solubility, empirical measurement of dry deposition, precipitation chemistry, and rates and processes of deposition to the forest. Atmospheric deposition supplied from 14% Mn to about 40% Zn, Cd, and SO4(2-), to about 99% Pb to the forest floor. Measured water solubility indicated that these metals may be readily mobilized following deposition. Dry deposition contributed about 20% of Cd and Zn, about 35% of SO(2-), about 55% of Pb and about 90% of Mn. Wet deposition rates for single events were one to four times greater than dry deposition rates. Thus, man's activities which influence the atmosphere may lead to a shift in the exposure of vegetation to certain nutrients and trace contaminants. Heavy metals can cause visible injury to plants, and toxic internal concentrations may exist in plants with no external damage. (Small-FRC)
W82-01491

METHYL BROMIDE AND BROMIDE-ION IN DRAINAGE WATER AFTER LEACHING OF GLASSHOUSE SOILS,
Rijksinstituut voor de Volksgezondheid, Bilthoven (Netherlands).
R. C. C. Wegman, P. A. Greve, H. De Heer, and P. Hamaker.
Water, Air, and Soil Pollution, Vol 16, No 1, p 3-11, July, 1981. 6 Fig, 11 Ref.

Descriptors: *Methyl bromide, *Bromides, *Greenhouses, Drainage water, Leaching, Irrigation water, Fish toxins, Water pollution sources, Agriculture.

The extent of contamination of surface water with methyl bromide and bromide-ion was investigated during the leaching period of two greenhouses treated with methyl bromide. Water samples were analyzed from irrigation water, drainage water, and recipient surface water. Maximum concentrations in drainage water were 9.3 gm/cu m for methyl bromide and 72 g/cu m for bromide ion. During the drainage procedure, fish mortality was observed in the ditches around one of the greenhouses. The rate of decline of methyl bromide was estimated for surface water. The average decline of methyl bromide in the drainage ditch was about 18%. The decline was the result of degradation and volatilization processes. The average half-life for the decline of methyl bromide in the ditch sections was calculated to be 6.6 hr at a water temperature of approximately 11 deg C. Gas chromatography was used to determine concentration levels. (Small-FRC)
W82-01492

GROUNDWATER CONTAMINATION BY TRACE LEVEL ORGANICS FROM A RAPID INFILTRATION SITE,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
M. B. Tomson, J. Dauchy, S. Hutchins, C. Curran, and C. J. Cook.
Water Research, Vol 15, No 9, p 1109-1116, September, 1981. 3 Fig, 3 Tab, 13 Ref.

Descriptors: *Organic compounds, *Wastewater disposal, *Rapid infiltration, Trace levels, Effluents, Secondary wastewater, Water pollution, Groundwater pollution, Path of pollutants, Infiltration, Chlorinated hydrocarbons, Phenols, Wastewater treatment, Phoenix, Arizona.

An experimental rapid land infiltration site in Phoenix, Arizona, removed about 92% of trace organics from secondary wastewater effluent. A total of 67 organic compounds were monitored in effluent and groundwater. Classes of compounds which were removed at greater than 90% efficiency were chloroaromatics, alkylbenzenes, alkylnaphthalenes, alcohols, ketones, indoles and indenes, and alkoxyaromatics. Compounds with removals of 70-90% were chloroalkanes, alkylphenols, alkanes, and amides. Only 2% of phthalates were removed. Groundwater damped concentration fluctuations, so that there was little variation over a 5-day period. (Cassar-FRC)
W82-01496

THE PHYSICOCHEMICAL SPECIATION OF CD, PB, CU, FE, AND MN IN THE FINAL EFFLUENT OF A SEWAGE TREATMENT WORKS AND ITS IMPACT ON SPECIATION IN THE RECEIVING RIVER,
Lancaster Univ., Bailragg (England). Dept. of Environmental Sciences.
D. P. H. Laxen, and R. M. Harrison.
Water Research, Vol 15, No 9, p 1053-1065, September, 1981. 11 Fig, 7 Tab, 48 Ref.

Descriptors: *Chelation, *Heavy metals, *Cadmium, *Speciation, Path of pollutants, Fate of pollutants, Chemical reactions, Metals, Copper, Lead, Iron, Manganese, Effluents, Rivers, Water quality, Wastewater treatment, Water pollution sources, Particulate matter.

A previously developed scheme for speciation of metals in fresh waters was applied to the analysis of a sewage treatment final effluent and to the river upstream and downstream of the effluent outfall. In this treatment plant Cd levels were high in influent and effluent. Additional metals studied were Pb, Cu, Fe, and Mn. The scheme separates particles into six size fractions. Further analysis determines total non-filterable metal, total filterable metal, ASV-labile metal, Chelex-labile metal and ultraviolet irradiation-ASV-labile metal. In the final effluent, the largest fraction (> 12 micrometers) contained 20% of the Cd, 52% of the Pb, 32% of the Cu, 58% of the Fe, and 13% of the Man. The smallest fraction (< 0.015 micrometers) contained 45% of the Cd, 10% of the Pb, 47% of the Cu, 4% of the Fe, and 83% of the Mn. Intermediate-sized fractions each contained up to 24% of the total amount of each metal. Cd and Cu, but not Pb and Fe, appeared to be complexed with organic matter. Comparing similar analyses of the river upstream and downstream of the outfall showed changes in speciation. A large part of the Cd was added to the smallest size fraction. The major proportions of Pb, Cu, and Fe were added to the colloidal and particulate size fractions, minimizing immediate toxicity to aquatic life. Most of the Mn was present in the smallest fraction. (Cassar-FRC)
W82-01498

RELEASE OF PHOSPHORUS BY CERTAIN BENTHIC INVERTEBRATES,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W82-01502

AN ANALYSIS OF ACIDIC PRECIPITATION IN SOUTH-CENTRAL ONTARIO USING AIR PARCEL TRAJECTORIES,
Ontario Ministry of the Environment, Toronto.
J. Kurtz, and W. A. Scheider.
Atmospheric Environment, Vol 15, No 7, p 1111-1116, 1981. 1 Fig, 6 Tab, 26 Ref.

Descriptors: *Acid rain, *Distribution patterns, Distribution, Precipitation, Rainfall, Acidity, Water pollution sources, Spatial distribution, Seasonal distribution, *Ontario, Canada, Sulfates, Nitrates.

An attempt is made to relate the deposition and concentrations of hydrogen, sulfate, and nitrate ions in precipitation collected at Muskoka-Haliburton to the directions of the associated air parcel trajectories. In this manner the relative contributions from the various directions were calculated to assess proposed strategies aimed at controlling and reducing the acidity in Ontario's precipitation. Precipitation collectors were located in central Ontario in an area underlain primarily by Precambrian bedrock with a thin, glacially derived overburden. A mixed deciduous/coniferous forest covers the area, and no large or industrial centers exists within 200 km. The majority of the precipitation collected is in the form of composite samples. The size of the data set for event samples is small. The characterization of acidic precipitation events using a single trajectory may be misleading. Even so, the results of the composite sample analysis show the maximum possible deposition of hydrogen, sulfate, and nitrate ions which could correspond to each octant of trajectory origin. In the case of each of the constituents, and both warm and cold seasons, the South and South-West octants are associated with the greatest maximum possible deposition, and the North octant is associated with the lowest possible deposition. The majority of these acidic deposits at Muskoka-Haliburton was associated with trajectories from the south or southwest. The average concentrations of the individual ions in precipitation for the south, southwest, west and northwest octants are all substantial. Precipitation from the remaining octants was very infrequent. (Baker-FRC)
W82-01513

RECENT ACIDIFICATION OF PRECIPITATION IN NORTH AMERICA,
Cornell University, Ithaca, NY. Section of Ecology and Systematics.
G. E. Likens, and T. J. Butler.
Atmospheric Environment, Vol 15, No 7, p 1103-1109, 1981. 4 Fig, 36 Ref.

Descriptors: *Acid rain, *Temporal distribution, United States, Rainfall, Air pollution, Fallout, *North America, Acidity, Chemical properties.

Analysis of precipitation occurring prior to the industrial revolution, and preserved in glaciers or continental ice sheets, reveals a pH of greater than 5.0. Remote areas such as Greenland and Antarctica have a pH of about 5.5 for precipitation currently falling. However, rain and snow falling over certain regions of the world are currently 5 to 30-40 times more acid than the lowest value expected for unpolluted atmospheres. This phenomenon is observed to be widespread in non-urban as well as urban areas throughout most of eastern North America and western Europe. Annual pH values average about 4.0 to 4.5 in parts of the northeast US and southeast Canada and northwest Europe. Individual storms have been recorded at pH 3.0. During 1959 through 1966 a sampling network was established throughout the conterminous United States. The vast majority of monthly pH readings from stations west of the Mississippi River were consistently above 5.6, with modal values in the high 6's. In contrast, monthly values east of the Mississippi were much more acidic. In the past two decades the southeastern United States has undergone the most rapid decrease in pH. This area has at the same time experienced an increase in atmospheric haze, presumably from increased urban and industrial activity, which would provide a regional source of anthropogenic emissions leading to the increased acidity. The longest continuous comprehensive record of precipitation chemistry in the US was obtained for the White Mountains area of New Hampshire in the Hubbard Brook Ecosystem Study. The pH has varied between 4.03 and 4.21 since the start of record keeping in 1964. Atmospheric deposition of heavy metals and various organic pollutants also occurs, and apparently has increased concurrently with increased acidity of precipitation in eastern North America. (Baker-FRC)
W82-01514

ENVIRONMENTAL RECOVERY IN A MARINE ECOSYSTEM IMPACTED BY A SULFITE PROCESS PULP MILL,
Victoria Univ. (British Columbia).
S. F. Cross, and D. V. Ellis.
Journal of the Water Pollution Control Federation, Vol 53, No 8, p 1339-1346, August, 1981. 8 Fig, 1 Tab, 10 Ref.

Descriptors: *Pulp and paper industry, *Monitoring, *Bioindicators, Aquatic life, *Ecological effects, Water pollution effects, Environmental effects, Fucus, Shores, Oligochaetes, Industrial wastes, Path of pollutants, Indicators, Neroutsos Inlet, *British Columbia, Sulfite mills.

A biological monitoring protocol was developed to assess the environmental recovery of the Neroutsos Inlet and Quatsino Sound, British Columbia, after installation of a sulfite process pulp mill pollution abatement program at the Rayonier Canada Limited plant. Three tests were used: qualitative estimation of enchytraeid/tubificid oligochaete species composition near high tide within the shoreline where obvious pollution impact was evident, Fucus-epifaunal amphipod abundance and diversity, and qualitative surveys of rocky shore fauna and flora. Sampling was done at 10 shoreline stations, representing both east and west sides of the inlet. Lumbricillus lineatus proved to be a good indicator of high concentrations of sulfite mill effluent. Moderate levels of sulfite mill effluent were reflected in the number and diversity of Fucus epifaunal amphipoda, particularly Allorchestes angusta. The point of maximum abundance of this species has moved closer to the outfall each year since 1977, indicating a decrease in pollution. Analysis of the shoreline flora and fauna illustrated the tendency of the effluent to have a greater effect on the east side of the inlet than on the west side. (Cassar-FRC)
W82-01548

RELATIONSHIP BETWEEN INCREASED CROP ACREAGE AND NONPOINT-SOURCE POLLUTION: A GEORGIA CASE STUDY,
Georgia Univ., Athens.
F. C. White, J. R. Hairston, W. N. Musser, H. F. Perkins, and J. F. Reed.
Journal of Soil and Water Conservation, Vol 36, No 3, p 172-177, May/June, 1981. 1 Fig, 7 Tab, 34 Ref.

Descriptors: *Economic aspects, *Agricultural runoff, *Nonpoint pollution sources, Soil erosion, Nutrients, Crop production, Cost analysis, *Cropland, Environmental effects, Pesticides, Nitrogen, Phosphorus, Farm wastes, Pollution load, Sediment load, Case studies, Georgia.

Between 1973 and 1976, 274,000 hectares of new cropland were brought into production in Georgia. On the average, each acre of this new cropland generated environmental loadings of 4.38 tons of sediment, 7.45 pounds of nitrogen, and 1.30 pounds of phosphorus. The impact of these nonpoint sources of pollution must be weighed against the economic benefit from the increased cultivation of land which was formerly woodland, pasture, wildlife areas, idle land, or wetlands. Some environmental impacts of new agricultural production which contribute to water quality deterioration of streams, lakes and rivers were considered. The production of increased loadings of phosphorus, nitrogen, storm runoff, sediments, and pesticides were studied in relation to the area of new cropland cultivated. Aggregate personal income for the state rose an average of $1.41 for each $1.00 increase in net farm income. Methods are recommended for calculating costs to the state for damage to water quality, soil stability, wildlife, and public health and recreation due to the impact of increased land cultivation. (Geiger-FRC)
W82-01550

STREAM NUTRIENT LEVELS AND PROXIMITY OF AGRICULTURAL AND FOREST LAND TO STREAMS: SOME RELATIONSHIPS,
Corvallis Environmental Research Lab., OR.
J. M. Omernik, A. R. Abernathy, and L. M. Male.
Journal of Soil and Water Conservation, Vol 36, No 4, p 227-231, July/August, 1981. 3 Fig, 3 Tab, 32 Ref.

Descriptors: *Nutrients, *Agricultural runoff, *Forests, Mathematical models, Runoff, Stream degradation, Land use.

The effectiveness of forest buffer zones in reducing nutrient levels in streams draining agricultural lands was evaluated by comparing stream nutrient concentrations from sets of 80 and 175 relatively large watersheds with varied patterns of forest and agricultural land use. Two mathematical models were used to test the importance of proximity of general land use types to main streams in affecting mean annual stream nutrient concentrations. Also, land use overlays for each of the 904 NES/NPS study watersheds were studied to detect disproportionate patterns of agriculture or forest proximity to main streams. The proximity of forest and agriculture to main streams did not bear a significant relationship to stream nutrient concentrations beyond that attributable to the proportion of the total watershed that these land uses comprise. It is suggested that over the years, an increasing percentage of nutrients associated with sediment intercepted by the buffer strips should eventually find its way into the streams. Thus, forested buffer strips may be only a temporary solution. (Small-FRC)
W82-01554

CHEMICAL AND BACTERIOLOGICAL QUALITY OF PASTURE RUNOFF,
Science and Education Administration, Lincoln, NE.
J. W. Doran, J. S. Schepers, and N. P. Swanson.
Journal of Soil and Water Conservation, Vol 36, No 3, p 166-171, May/June, 1981. 7 Tab, 27 Ref.

Descriptors: *Fate of pollutants, *Animal wastes, *Feedlot runoff, Feedlot wastes, *Enteric bacteria, Farm wastes, Coliforms, Streptococcus, Feces, Cattle, Bacteria, Agricultural runoff, Water quality standards, Urban runoff, *Pastures, *Nebraska.

Pasture runoff in south central Nebraska is influenced by grazing cattle and natural background characteristics. Chemically, the quality of runoff water from grazed pasture was better than that from unstocked grassland. Pasture runoff, which was of better quality than runoff from urban areas or cultivated cropland, was within recommended water quality standards. Fecal coliforms were increased 5- to 10-fold in runoff from areas grazed by cattle. Levels of fecal coliform were similar in rainfall runoff from both grazed and ungrazed pasture and cropland and urban areas. The fecal coliform counts of the runoff from these four areas exceeded water quality criteria more than 90% of the time. The fecal coliform/fecal streptococci ratio of grazed and ungrazed pasture was similar to wildlife feces, suggesting a large natural background input for these microorganisms. The water quality criteria for bacteriological inputs for runoff from pasturelands should be reevaluated in light of these findings. (Geiger-FRC)
W82-01555

PARAMETERIZATION OF CONTAMINANT TRANSPORT THROUGH AN ANISOTROPIC UNCONFINED AQUIFER,
Canada Centre for Inland Waters, Burlington (Ontario).
A. G. Bobba, and R. P. Bukata.
Nordic Hydrology, Vol 11, No 3/4, p 187-208, 1980. 10 Fig, 17 Ref.

Descriptors: *Groundwater movement, *Aquifers, *Anisotropy, Path of pollutants, Porous media, Unconfined aquifers, Model studies, Adsorption, Solute transport.

A duo two-dimensional deterministic model which considers dispersion, convection, and chemical adsorption processes of contaminant transport in a porous medium was developed and applied to a homogeneous and anisotropic unconfined aquifer. Finite difference techniques were used to consider the effects on contaminant transport of anisotropic groundwater flow (indicated by principal velocity ratios), adsorption coefficient, and dispersivity ratios. Of these parameters the principal velocity ratio (degree of aquifer anisotropy) had a dominant influence on the transport of subsurface contaminants. Contaminant concentration iso-concentration curves were illustrated for a hypothetical waste disposal site on a recharge area. These showed that the contaminant was transported a shorter distance in the lateral direction than in the downstream direction. Some transport was also noticeable in the upstream direction, probably as a result of molecular dispersion. Although this paper considers a simple aquifer, current work, soon to be reported, is directed toward aquifers closer to natural basin conditions. (Cassar-FRC)
W82-01570

EFFECTS OF WATER AND NITROGEN MANAGEMENT ON NITRATE LEACHING LOSS FROM SANDS,
Nebraska Univ., Lincoln. Dept. of Agricultural Engineering.
D. G. Watts, and D. L. Martin.
Transactions of the ASAE, Vol 24, No 4, p 911-916, July/August, 1981. 6 Fig, 2 Tab, 12 Ref.

Descriptors: *Nitrates, *Leaching, Irrigation management, Nitrogen, Soil properties, Sand, Permeability, Groundwater, Groundwater pollution, Water quality, Model studies, Great Plains, *Irrigation effects.

The contributions of nitrate to the groundwater system were compared as they might result from the wide range of existing management practices on irrigated sands in the central Great Plains. A mechanistic model of the soil-plant-water-nitrogen system was developed for irrigated corn on sands. It simulates the biological transformation of various nitrogen forms in the soil, nitrogen uptake by the crop, and the loss of water and nitrate from the root zone. Corn having a 105-107 day relative maturity range was simulated. The soil for which the simulations were performed is a Valentine very fine sand, with an available water holding capacity of about nine to ten percent by volume. Two nitrogen amounts, 168 and 253 kg/ha, were used in the studies. The nominal irrigation frequency in the simulations was four days. A maximum system

capacity of 0.94 cm/day was assumed. Four important factors that were seen to affect nitrate leaching loss and were controllable included irrigation amounts, nitrogen source, nitrogen amount, and timing of nitrogen application. For years of normal rainfall, about 30-35 kg/ha of nitrate leaching loss may be expected during the growing season when 168 kg/ha of N is applied to the irrigated corn. When growing season percolation is 12 cm or less, leaching loss of nitrate during the growing season is essentially independent of N source. Nitrate leaching loss increases due to either rain or excess irrigation. Nitrate uptake decreased as leaching loss increased. Nitrate uptake increased when N applications were increased by 50%. Leaching losses during the growing season were slightly increased. Nitrate residual is considerably increased, creating the potential for additional leaching loss during the following spring. (Baker-FRC)
W82-01581

CADMIUM, LEAD, MERCURY, ARSENIC, AND SELENIUM CONCENTRATIONS IN FRESHWATER FISH, 1976-77-NATIONAL PESTICIDE MONITORING PROGRAM,
Columbia National Fisheries Research Lab., MO.
T. W. May, and G. L. McKinney.
Pesticides Monitoring Journal, Vol 15, No 1, p 14-38, June, 1981. 1 Fig, 4 Tab, 91 Ref.

Descriptors: *Heavy metals, *Fish, *Water pollution sources, Industrial wastes, Air pollution effects, Cadmium, Lead, Mercury, Arsenic, Selenium, Monitoring, Rivers, Path of pollutants.

Heavy metal data gathered by the National Pesticides Monitoring Program (NPMP) during 1976-77 are presented and interpreted. Freshwater fish were collected at 98 monitoring stations and analyzed for residues of cadmium, lead, mercury, arsenic, and selenium. Range and geometric mean values in mg/kg wet weight were: Cd, 0.01-1.04, 0.07; Pb, 0.10-4.92, 0.32; Hg, 0.01-0.84, 0.11; As, 0.05-2.92, 0.27; and Se, 0.05-2,87 0.56. Cadmium concentrations have decreased since 1972; the highest concentration was found in carp on the Verdigris River near a zinc plant. There has been no significant change in lead concentrations over the years for which data are available, and the sources of lead are industrial effluents and aerosols. Mercury levels have been declining due to reduced emissions and reduced use. Paper pulping and chlor-alkali operations were common sources. Arsenic levels in fish have increased, possibly because of air pollution, smelter solid wastes, and the use of arsenical pesticides. Selenium contamination is not widespread and is associated with geologic sources and industrial effluents. All five trace elements may undergo biologically mediated transformation reactions that yield organometallic compounds that are routed through the food chain. (Small-FRC)
W82-01584

CHRYSOTILE ASBESTOS FIBERS IN DRINKING WATER FROM ASBESTOS-CEMENT PIPE,
Wisconsin Univ. Madison. Dept. of Preventive Medicine.
M. S. Kanarek, P. M. Conforti, and L. A. Jackson.
Environmental Science and Technology, Vol 15, No 8, p 923-925, August, 1981. 3 Tab. 14 Ref.

Descriptors: *Potable water, *Asbestos, pipes, Asbestos-cement pipe, Water pollution sources, *Pollutant identification, *Drinking water, Water distribution, Corrosion, *San Francisco Bay area.

The water sampling program for the San Francisco Bay epidemiology studies was designed to assess the levels of asbestos in drinking water of the area's different water distribution systems. The asbestos content of distilled water samples was below detectable limits of the analysis. In one major distribution system mean chrysotile counts were 115 times greater in drinking water after flow through the pipe. This demonstration of substantial increases in asbestos fiber counts in nonaggressive drinking water raises questions regarding the validity of aggressiveness indexes for prediction of fiber release from asbestos-cement pipes. A possible explanation of the increase in fiber counts after flow through asbestos-cement pipes is that the fibers already present in the water from natural sources break up, thus yielding higher counts. However, the water samples after flow through asbestos-cement pipe have a larger proportion of longer fibers than the before asbestos-cement pipe samples. Thus the theory of fiber breakup seems to be invalidated. Other factors that might affect the release of fibers from the pipe include size of pipe, flow rate of water, alternate wetting and drying of surfaces, quality of joint materials used, corrosive cleaners in use to flush sections of pipe, and tapping of pipe. Hydrants and other dead ends in a water distribution system often act as a reservoir for fibers released by trapping at other places in the system. (Baker-FRC)
W82-01592

5C. Effects Of Pollution

ACUTE TOXICITY OF LEACHATES FROM COAL GASIFICATION AND LIQUEFACTION SOLID WASTES TO THE FATHEAD MINNOW, PIMEPHALES PROMELAS,
Illinois State Natural History Survey, Urbana. Aquatic Biology Section.
J. J. Suloway, R. M. Schuller, and R. A. Griffin.
Journal of Environmental Science and Health, Part A, Vol 16, No 4, p 419-445, 1981. 2 Fig, 9 Tab, 28 Ref.

Descriptors: *Toxicity, *Leachates, *Coal gasification, *Fathead minnows, Fish, Liquefaction, Bioassay, Effluents, Solid wastes, Industrial wastes, Water pollution effects.

Earlier studies have indicated that coal conversion wastes, which contain relatively large concentrations of accessory elements and which produce acidic leachates, pose a potential hazard to water resources. Surface runoff from exposed piles of solid wastes could enter into streams and lakes, and the percolation of precipitation through wastes deposited in landfills could contaminate groundwater. The acute toxicity of leachates generated from Lurgi gasification ashes, an H-Coal liquefaction residue, and an SRC-1 liquefaction residue was investigated through 96-hour static bioassays using 1 to 6 day old fathead minnow fry. The leachates generated from the Lurgi gasification ash contained concentrations of several chemicals that exceeded recommended water quality standards. Leachates generated from the liquefaction residues in which the pH was not adjusted were acutely toxic. All of the acidic leachates were acutely toxic to the fry, requiring dilutions ranging from 1:10 to as high as 1:2000 to eliminate mortality. Total mortality occurred when the fry were exposed to acidic reconstituted water for 96 hours. Some of the acidic leachates also contained concentrations of aluminum, cadmium, chromium, zinc, copper, and nickel which have been shown to be acutely toxic to fish. Mortality was probably caused by the combined effects of pH and total ionic strength of the leachates. Much of the enormous quantity of solid wastes which will be generated by coal liquefaction and gasification will probably be redeposited on the coal mining site or in landfills, where percolation of acid mine drainage through the wastes could produce highly toxic acidified leachates. (Carroll-FRC)
W82-01108

A QUANTITATIVE STUDY OF SHORELINE MARSH COMMUNITIES ALONG LAKE HURON IN ONTARIO,
University of Western Ontario (London). Dept. of Plant Sciences.
For primary bibliographic entry see Field 2H.
W82-01122

INTERACTIVE EFFECTS OF METALS IN MIXTURES ON BIOMASS PRODUCTION KINETICS OF FRESHWATER COPEPODS,
Canada Centre for Inland Waters, Burlington, (Ontario).
U. Borgmann.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 37, No 8, p 1295-1302, August, 1980. 3 Fig, 5 Tab, 12 Ref.

Descriptors: *Copepods, *Metals, *Toxicity, Water quality, Natural waters, Synergistic effects, Productivity, Population dynamics, Water pollution effects.

The concept of additivity of the inverse of growth rates and mortality rates is expanded to provide estimates of the toxicity of metal mixtures to natural assemblages of freshwater copepods. Fourteen binary mixtures of the metals cadmium, copper, mercury, lead, zinc, and arsenic were used. The average observed growth time increase in copepods was 17% larger than the average calculated growth time increases, indicating a slight but sugnificant synergism. Synergism in multimetal mixtures appears to be cumulative. One of the 15 possible binary mixtures, zinc:arsenic, demonstrated a large difference between the calculated and the observed growth rates. For all other mixtures studied, most of the toxicity was accounted for by the summation of noninteractive, single metal effects. The use of the toxic unit concept, which assumes additivity of concentrations rather than effects, would have predicted antagonism in most metal interactions. Although the toxic unit concept may be of use for water quality management if more complete information is not available, it cannot be used to correctly predict synergism or antagonism of metal mixtures. (Baker-FRC)
W82-01125

PHOSPHORUS UPTAKE DYNAMICS AS RELATED TO MATHEMATICAL MODELING OF CLADOPHORA AT A SITE ON LAKE HURON,
Michigan Univ., Ann Arbor.
M. T. Auer, and R. P. Canale.
Journal of Great Lakes Research, Vol 6, No 1, p 1-7, 1980. 6 Fig, 1 Tab, 25 Ref.

Descriptors: *Phosphorus, *Algae, *Cladophora, *Lake Huron, Model studies, Mathematical models, Great Lakes, Lakes, Nutrients, Eutrophication, Fate of pollutants, Water pollution effects.

Cladophora collected near a wastewater treatment plant at Harbor Beach, Michigan, on Lake Huron, had high levels of internal phosphorus (0.25%) and low or negative P uptake rates. Cladophora in water with low levels of dissolved P had low internal P levels (0.01%) and rapid P uptake rates. This research is part of a continuing study directed at understanding and control of nuisance growths of this attached, filamentous green alga in the Great Lakes. A mathematical model was developed to predict the response of Cladophora to management and control alternatives. Preliminary model simulations of Cladophora biomass, internal P, and external P were qualitatively similar to observed field data. (Cassar-FRC)
W82-01149

SOME EFFECTS OF AGRICULTURAL LAND USE ON STREAM INSECT COMMUNITIES,
Waterloo Univ. (Ontario). Dept. of Biology.
K. W. Dance, and H. B. N. Hynes.
Environmental Pollution, (Series A), Vol 22, No 1, p 19-28, May, 1980. 1 Fig, 4 Tab, 14 Ref.

Descriptors: *Land use, *Insects, *Water quality, *Agriculture, Water pollution effects, Macroinvertebrates, Invertebrates, Suspended solids, Soil erosion, Erosion, Species composition, Agricultural runoff, Runoff, Midges, Caddisflies, Aquatic animals, Canagagigue Creek, *Ontario.

Invertebrate community composition was studied in two branches of the Canagagigue Creek, Ontario. Although the two subbasins were similar in 1840, the west branch now is 6.9% forest, 23.7% bank cultivated, and 70% raw soil at the bank. It has 6.6 tons per day of suspended sediment and 964 kg per year of allochthonous organic input (serving as invertebrate food). In the west branch (1976 figures) total coliforms were 2046 per 100 ml; total P, 1.24 mg per liter; nitrites-nitrates, 3.24 mg per liter; suspended solids, 51 mg per liter. Widespread agricultural practices include manure spreading on

fields in winter and on stream banks in summer, wading by cattle in the stream, intensive corn cropping, and uncontrolled barnyard runoff. In contrast, the east branch is 34.1% forest, 13.4% bank cultivated, and 36% raw soil at the bank. It has 3.9 tons per day suspended sediment, and 5103 kg per year allochthonous organic input. In 1976 total coliforms in the last branch were 989 per 100 ml; BOD 1.2, mg per liter; dissolved oxygen, 9.0 mg per liter; total P, 0.079 mg per liter; nitrite-nitrate, 4.07 mg per liter; suspended solids, 114 mg per liter. The east bank is largely forested with little agriculture. Another important difference is the discharge regime. In the west branch flow is 4200-7840 liters per sec in the spring snow melt period with 6 weeks of no flow in summer. In the east branch spring discharges are 2000 liters per sec, summer flow 50-170 liters per sec. The west branch contained 2 species of Plecoptera, 7 species of Trichoptera, 98 taxa (40 chironomids), and no shredders. The east branch contained 8 species of Plecoptera, 15 of Trichoptera, and 110 taxa (36 chronomids). (Cassar-FRC)
W82-01159

TOXICITY AND BIOACCUMULATION OF ENDRIN AND METHOXYCHLOR IN AQUATIC INVERTEBRATES AND FISH,
Environmental Protection Agency, Duluth, MN.
R. L. Anderson, and D. L. DeFoe.
Environmental Pollution, (Series A), Vol 22, No 2, p 111-121, June, 1980. 3 Fig, 3 Tab, 21 Ref.

Descriptors: *Insecticides, *Toxicity, *Bioaccumulation, *Aquatic animals, Methoxychlor, *Endrin, Pesticides, Invertebrates, Accumulation, Stoneflies, Caddisflies, Isopods, Snails, Fish, Bullhead, Water pollution effects.

Endrin was more toxic than methoxychlor to stoneflies, caddisflies, isopods, snails, and bullheads in a 28 day test. Tests were performed in a flowing water system using unfiltered Lake Superior water. Concentrations for endrin were 0.03, 0.07, 0.15, 0.26, and 0.60 micrograms per liter and for methoxychlor, 0.15, 0.42, 1.30, 2.17, and 4.23 micrograms per liter. The isopod Asellus communis was most sensitive to methoxychlor; EC50 (behavior) was 1.78 micrograms per liter at 4 days, and 0.42 at 28 days; LC50 (survival) was 1.75 at 7 days and 0.42 at 28 days. Caddisflies (Hydropsyche sp.) were less sensitive. LC50 was 2.90 micrograms per liter for methoxychlor at 14 days and 1.30 micrograms per liter at 28 days. Stoneflies (Pteronarcys dorsata) and snails (Physa integra) showed no deaths in 28 days in 4.20 micrograms per liter methoxychlor. Endrin toxicities (all in micrograms per liter) were as follows: caddisfly (Brachycentrus americanus) EC50, 0.23 at 4 days, 0.017 at 14 days; LC50, 0.34 at 4 days and greater than 0.34 at 21-28 days; stonefly, EC50, 0.22 at 4 days and 0.05 at 21-28 days, LC50, 0.28 at 7 days, 0.07 at 28 days; bullhead (Ictalurus melas), LC50, 0.45 at 4 days, 0.10 at 28 days. Bioaccumulation factors were: for methoxychlor, stonefly, 348-1130, and snail, 5000-6710; for endrin, stonefly, 610-1033. (Cassar-FRC)
W82-01160

PHYTOPLANKTON PRODUCTIVITY AND STANDING CROP IN THE VICINITY OF THE LAKE HURON-SAGINAW BAY FRONT,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 2H.
W82-01164

POSTSPAWNING MORTALITY OF RAINBOW SMELT IN WESTERN LAKE SUPERIOR,
Brigham Young Univ., Provo, UT. Dept. of Zoology.
W. F. Schaefer, R. A. Heckmann, and W. A. Swenson.
Journal of Great Lakes Research, Vol 7, No 1, p 37-41, 1981. 2 Fig, 3 Tab, 23 Ref.

Descriptors: *Fish populations, *Thermal stress, Heated water, Harbors, Thermal pollution, Smelt, Temperature effects, Fungus, Fish diseases, *Lake Superior, Fish mortality, Rainbow smelt.

Population characteristics and the possible causes of die-offs in rainbow smelt in Lake Superior were investigated. During the springs of 1976 and 1977, 1,958 mature adult rainbow smelt that survived spawning and 1,014 post-spawning dead rainbow smelt were examined. Rainbow smelt were collected during spawning runs at five stations, in the Amnicon River, Burle River and near-shore points off Wisconsin Point. Intensities of the die-offs were determined by counting dead fish along the beach, at 12 stations located east of Superior-Duluth along the north and south shorelines to the Cascade River in Minnesota and Cornucopia Beach in Wisconsin. The die-off of smelt in western Lake Superior reached maximum intensity 3-5 weeks after spawning peaked at each location and lasted about 2 weeks. No dead smelt were found on the beaches prior to or during spawning. The density of dead smelt on beaches decreased with distance from the Superior-Duluth harbor. All dead rainbow smelt were infected with fungus, with the most common locations being the base of the pectoral and pelvic fins and the area around the vent. Fungus was also noted on the dorsal surface of the head and on the caudal peduncle. The fungus was determined to be a non-sexual form of Saprolegnia, probably S. parasitica. The most probable cause of the die-off was temperature stress on spawning smelt in the spawning areas, which increased the susceptibility of smelt to the fungus and may also have produced an osmoregulatory imbalance. The preferred temperature for rainbow smelt is 7 degrees Centigrade. Variation in temperature is considerable between waters in the harbor and the lake, with surface water temperatures in the harbor area of about 15 degrees Centigrade. (Baker-FRC)
W82-01189

EFFECTS OF ATMOSPHERIC PRECIPITATION ADDITIONS ON PHYTOPLANKTON PHOTOSYNTHESIS IN LAKE MICHIGAN WATER SAMPLES,
Argonne National Lab., IL.
For primary bibliographic entry see Field 2H.
W82-01196

RADON-222, IN POTABLE WATER SUPPLIES OF NEW ENGLAND,
Maine Univ. at Orono. Dept. of Physics.
For primary bibliographic entry see Field 5B.
W82-01221

EFFECTS OF LOGGING ON MACROINVERTEBRATES IN STREAMS WITH AND WITHOUT BUFFER STRIPS,
California Univ., Berkeley. Dept. of Forestry and Conservation.
J. D. Newbold, D. C. Erman, and K. B. Roby.
Canadian Journal of Fisheries and Aquatic Sciences, Vol 37, No 7, p 1076-1085, July, 1980. 2 Fig, 5 Tab, 49 Ref. OWRT-A-047-CAL(6).

Descriptors: *Water pollution effects, *Macroinvertebrates, *Logging, Stream pollution, Aquatic populations, Species diversity, Mathematical studies, Forest watersheds, Chironomids, Population density, California.

Populations of stream macroinvertebrates in commercial logging and controled watersheds throughout various sample sites of northern California were compared by a nonparametric test of community dissimilarities within matched blocks of two control and one or two treated stations. When Euclidean distance and mutual data were used as dissimilarity indices, significant effects of logging on unprotected streams were observed. Unprotected streams showed higher densities of total macroinvertebrate fauna and certain Chironomidae and lower Shannon diversity values than control waters. Narrow buffer strips (< 30 m) helped to maintain normal Euclidean distance levels but had little effect on population diversity. Streams with wide buffer strips (> 30 m) were similar to control streams in their macroinvertebrate communities and sometimes had a greater amount of diversity, showing effective protection from logging influences. (Geiger-FRC)
W82-01227

EFFECT OF KEPONE ON ESTUARINE MICROBIAL ACTIVITY,
Maryland Univ., College Park. Dept. of Microbiology.
S. A. Orndorff, and R. R. Colwell.
Microbial Ecology, Vol 6, No 4, p 357-368, 1980. 3 Fig, 2 Tab, 20 Ref. OWRT-B-034-MD(3).

Descriptors: *Insecticides, *Estuarine environment, *Microbiological studies, *Kepone, Water pollution effects, Water pollutants, Pesticides, In situ tests, Inhibitors, *Chesapeake Bay.

Natural waters have become contaminated with pesticides, such as Kepone, which may have deleterious effects on microorganisms in the waters which are responsible for mineralization of organic matter and for nutrient regeneration. A method adapted from that of Kogure et al. was used for determination of total numbers of actively metabolizing estuarine bacteria in the presence of the chlorinated insecticide Kepone in the Chesapeake Bay. Observed relationships between results obtained using this method, heterotrophic activity measurements, and a specific activity index are presented. In situ heterotrophic uptake of mixed carbon 14-amino acids and direct viable cell (DVC) count of water samples from the Bay were not significantly affected by concentrations of Kepone not exceeding 0.01 milligrams per liter. Maximum inhibition of heterotrophic uptake (about 85 to 90 percent) and of DVC count (between 45 and 97 percent) was evident when Kepone concentrations exceeded 0.2 milligrams per liter. A specific activity index (either Metabolic Activity/DVC or Kepone-resistant DVC), heterotrophic uptake, and DVC count were found to be statistically correlated to one another, but negatively correlated with concentrations of Kepone. The direct viable cell count proved to be a rapid, simple method for estimating the effect of Kepone on in situ estuarine microbial activity. (Carroll-FRC)
W82-01231

POTENTIAL HEALTH HAZARDS FROM MICROBIAL AEROSOLS IN DENSELY POPULATED URBAN REGIONS,
Louisville Univ., KY. Dept. of Biology.
L. S. Cronholm.
Applied and Environmental Microbiology, Vol 39, No 1, p 6-12, January, 1980. 1 Fig, 5 Tab, 11 Ref. OWRT-A-068-KY(2).

Descriptors: *Bacteria, *Wastewater treatment, Sludge, Human diseases, Water treatment facilities, Microorganisms, Feces, *Coliforms, *Aerosols, Air pollution, Fallout, Sludge, Activated sludge, Bacterial analysis.

This study examined whether the risk of exposure to microbial aerosols in the vicinity of aerobic sewage treatment plants could be determined with sufficient accuracy to assist in public policy decisions regarding the design and location of such plants. Samples of air upwind and downwind of the treatment plants were collected with disposable two-stage Andersen samplers. Three treatment plants were selected for study. Two of these were typical of the small activated sludge plants located in subdivisions; they treat domestic sewage. The third is the largest facility in the area, which is separate from the Louisville, Kentucky, centralized treatment facility and treats a combination of domestic and industrial wastes. Aerosolized bacteria were recovered up to 930 meters downwind of the three plants. Some homes are within this distance. Although the bacterial counts taken on foliage in the area decreased rapidly, at 48 hr after exposure they were significantly higher than the counts on unexposed leaves. The 50% lethal dose of aerosolized Klebsiella pneumoniae was comparable to the 50% lethal dose of a virulent clinical isolate, and enteric bacteria were recovered from the respiratory organs of mice after forced inhalation adjacent to an aerated sludge tank. Coliform density in the effluents of the plants was inversely related to the airborne bacterial load at those plants. This relationship was attributed to the correlation between effluent quality and extent of aeration of activated sludge. Airborne enteric bac-

teria were also isolated near a decorative fountain used by humans for wading. (Baker-FRC)
W82-01232

HEALTH EFFECTS ASSOCIATED WITH WASTEWATER TREATMENT AND DISPOSAL,
Environmental Protection Agency, Cincinnati, OH.
N. E. Kowal, and H. R. Pahren.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 776-786, June, 1981. 133 Ref.

Descriptors: *Wastewater disposal, *Sludge disposal, *Public health, Literature review, *Wastewater treatment, Land disposal, Soil amendments, Pathogens, Bacteria, Viruses, Composting, Aspergillus, Parasites, Water pollution sources, Heavy metals, Cadmium, Zinc, Agriculture, Water reuse.

This literature review discusses health effects associated with wastewater treatment plants, composting of sludge, land application of wastewater and sludge, and use of renovated water. Many cases of plant workers exposed to pathogens and chemicals are reported--chlorinated organics, hydrogen sulfide, bacteria, and endotoxins. Several studies done on risk of bacterial and viral exposures for plant workers and nearby populations failed to show significantly higher illness rates. Several papers discussed the hazards of wastewater discharges with respect to swimming, transmission of antibiotic resistance factors, and viruses. Although exposure to sludge composting did not produce a high incidence of illness, protective measures and regular health examination for workers are recommended. Of particular concern is Aspergillus fumigatus. Studies on land application of wastewater and sludges revealed few ill effects in animals fed sludge, crops grown on sludge amended soils, or exposed humans. However, some potential and actual cases of disease transmission were noted: grazing animals, persons living in kibbutzim practicing wastewater spray irrigation, well water pollution, a cholera outbreak, and leptospirosis incidence. Potential chemical threats from land application are pesticides, polynuclear aromatic hydrocarbons, toxic trace elements (particularly Cd), and nitrates. There is not much information on health effects of treated wastewater reused as part of the potable water supply, but it is preferable to use renovated water for nonpotable uses. Of great concern are pathogens and mutagenic or carcinogenic materials, such as halogenated organics, in reclaimed water. (Cassar-FRC)
W82-01255

MARINE AND ESTUARINE POLLUTION,
California State Univ., Long Beach.
D. J. Reish, G. G. Geesey, P. S. Oshida, F. G. Wilkes, and A. J. Mearns.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 925-949, June, 1981. 6 Tab, 351 Ref.

Descriptors: *Marine environment, *Literature review, *Water pollution sources, Sludge, Ocean dumping, Waste disposal, Bioaccumulation, Toxicity, Pesticides, Organic compounds, Pollutants, Microorganisms, Viruses, Bacteria, Effluents, *Estuarine environment.

Recent advances in the area of marine and estuarine pollution are cited in this literature review. Two international marine pollution symposia were published with topics including heavy metal pollution, radioactive materials, oil and related substances, pesticides, industrial and domestic pollution, environmental evaluation and management, biochemical, physiological, genetic, and behavioral effects, pathobiology, and monitoring. In the area of pesticides, investigations were made concerning the value of various methods of study, the acute effects of certain chemicals, sublethal effects, metabolism, fate, bioaccumulation, and residues. In the area of microbiology specific work was done on microorganisms as pollutants, bacterial disease, viruses, pollutant-microbe interactions, and the conducting of surveys. For complex effluents and environments papers focused on the toxicity of contaminants to marine and estuarine animals. Oil pollution studies considered specific analytical methods, residues of oil in water and sediment, residues in biota, dispersants, field studies, toxicity and sublethal effects, bioaccumulation, diseases and abnormalities, and the ocean dumping of sludge plus methods of dredging and recovery. (Baker-FRC)
W82-01274

THERMAL EFFECTS,
Rexnord Inc., Milwaukee, WI.
J. B. Cravens.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 949-965, June, 1981. 9 Fig, 194 Ref.

Descriptors: *Thermal pollution, *Literature review, Heated water, Plumes, Thermal power, Thermal stress, Thermal water, Lakes, Reservoirs, Plants, Aquatic animals, Model studies, Streams, Rivers, Estuarine environment.

Recent research in the area of thermal effects as they relate to water pollution is cited in this literature review article. A far-field mathematical model was presented for numerical simulation of transient one- or two-dimensional thermal distribution in regions of severe reversing-flow conditions. Power plant intake effects were assessed at population and ecosystem levels. Temperature guidelines for power stations in Canada were concerned with protection of ichthyoplankton. The MacArthur-Wilson equilibrium model was used to analyze zooperiphyton on experimental substrates. Water temperature time series data was analyzed, leading to development and parameterization of a stochastic model able to simulate variations in water temperature characteristic of littoral zones of North American lakes. Specific site studies were conducted at cooling lakes and reservoirs, in specific streams and rivers, at the Great Lakes, in marine and estuarine systems, and in experimental ecosystems. Effects of hot-water evacuation were studied on growth and reproduction of plants in the vicinity. Effects of thermal water pollution were also studied on the reproduction, development, morphology, and feeding of animal species in the general area. The effects of temperature on specific diseases and parasites were investigated along with biochemical reaction studies. Some beneficial uses of warmer than natural water were also considered. (Baker-FRC)
W82-01275

BIOASSAYS - PROCEDURES AND RESULTS,
Ecological Analysts, Inc., Sparks, MD.
For primary bibliographic entry see Field 5A.
W82-01277

BIOACCUMULATION AND TOXICITY OF HEAVY METALS AND RELATED TRACE ELEMENTS,
O'Brien and Gere Engineers, Inc., Syracuse, NY.
C. B. Murphy, Jr.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 993-999, June, 1981. 1 Tab, 96 Ref.

Descriptors: *Heavy metals, *Environmental effects, *Bioaccumulation, Biological magnification, Acid rain, Mercury, Lead, Zinc, Copper, Cadmium, Lakes, Estuaries, Environmental pollutants, Toxicity, Water pollution effects, Path of pollutants.

Several studies have identified the presence of heavy metals in the environment. Average mercury levels in fish taken from New York waters appeared to be about 30% lower in recent tests than they had been in 1970 data. However, mercury levels were seen to be increasing in fish from several large non-industrialized Adirondack Mountain lakes, suggesting effects from acid rain. Cadmium and lead have been found in mussels from the St. Lawrence estuary. Studies are also cited dealing with the detection of copper and zinc in environmental waters and the effects of these metals on the surrounding environment. Bioconcentration studies have indicated that age of the cell population and concentration of the pollutant are factors which influence the degree of concentration of a chemical in an organism or in the tissue of an organism. Cadmium accumulation in sea worms, mercury accumulation in rainbow trout, pollutant biomagnification in bluegill sunfish, and the mercury content of pike have all been investigated. Toxicity studies and literature reviews have been conducted for arsenic, cadmium, copper, chromium, lead, mercury, zinc, selenium, and other metals. The effect of water hardness on toxicity of cadmium to aquatic organisms was investigated, along with the chloride dependent cellular detoxification mechanism. The role of bacteria in the detoxification of heavy metals in the environment, the effect of complexation of metals with synthetic agents, and the influence of water temperature on the transfer of methylmercury in the freshwater trophic chain were studied. Theoretical and mathematical approaches to the combined effects on freshwater fish and other aquatic life of mixtures of toxicants in water were also studied. (Baker-FRC)
W82-01278

EFFECTS OF POLLUTION ON FRESHWATER INVERTEBRATES,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
A. L. Buikema, Jr., E. F. Benfield, and B. R. Niederlehner.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1007-1015, June, 1981. 105 Ref.

Descriptors: *Invertebrates, *Water pollution effects, *Literature review, Bibliographies, Toxicity, Bioindicators, Bioassay, Organic compounds, Metals.

A review is presented of 1981 literature dealing with the effects of pollution on freshwater invertebrates, which includes the general topics of methods, microcosms, communities, cladocera, other zooplankters, amphipods, decapods, insects, mollusks, and protozoa. The proceedings of a meeting on invertebrate bioassays emphasized toxicity testing. The proceedings covered the advantages and disadvantages of using the following in toxicity tests: Daphnia, chironomids, Hexagenia, amphipods, copecodes, molluscan larvae, polychaetes, and grass shrimp. A literature review paper considered other potential species and toxicity testing methods. An extensive review on polycyclic aromatic hydrocarbons in the aquatic environment is referenced, as is a similar review dealing with benzene, xylene, and toluene. Toxicity of metals was the subject of a new handbook and an aquatic toxicology meeting. A book on ecosystem restoration dealt with recovery processes in damaged ecosystems. A review is referenced which concerns aspects of the development of water quality standards. (Small-FRC)
W82-01280

FRESHWATER MACROINVERTEBRATES,
Michigan Univ., Ann Arbor. School of Natural Resources.
M. A. Quigley.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1015-1027, June, 1981. 191 Ref.

Descriptors: *Macroinvertebrates, *Water pollution effects, *Literature review, Bibliographies, Ecology, Industrial wastes.

A review of 1980 literature on freshwater macroinvertebrates is presented which includes the general topics of indexes and indicators, organic and other wastes, physical environmental alterations, distribution and habitat requirements, production, food and feeding, periodicity and drift, animal-sediment interactions, and methods. A book on oligochaete aquatic biology and a proceedings on Corbicula cover information on population dynamics, the effects of human activities, and other topics. A collection of papers on Ephemeroptera and a similar collection on Chironomidae are referenced which concern the biology and ecology of these

macroinvertebrates. References dealing specifically with water pollution issues include a survey of the effects of coal mining on a stream environment and macroinvertebrate communities and an examination of the effects of coal industry wastes on a small river. The effects of organic pollutants in the River Trent and the consequences of acidified lakes in Sweden were considered by other referenced papers. (Small-FRC)
W82-01281

THE EFFECTS OF POLLUTION ON FRESHWATER FISH,
Environmental Protection Agency, Duluth, MN.
R. L. Spehar, A. E. Lemke, Q. H. Pickering, T. H. Roush, and R. C. Russo.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1028-1076, June, 1981. 1 Tab, 376 Ref.

Descriptors: *Fish, *Water pollution effects, *Literature review, Fish toxins, Bibliographies, Organic compounds, Water quality, Industrial wastes, Environmental effects.

A review is presented of 1980 literature on the effects of pollution on freshwater fish. An extensive table is included which summarizes the acute and chronic toxicity of inorganic and organic pollutants to freshwater fish. Published literature included many reviews and symposia which presented information on water quality, physical and chemical pollutants, and industrial and municipal effluents. These include the aquatic toxicity of Cu, Cn, V, and chlorophenol, and the effects of natural and artificial sources of radiation. Other papers concerned the effects of Hg, the effects of mosquito control agents, and the relationship between biotransformation and toxicity of xenobiotic chemicals in fish. Most of the articles cited deal with the effects of chemical pollutants. Papers are cited which deal with the effects of chlorine and wastewater, and pulp and paper wastes. (Small-FRC)
W82-01282

SUBSTRATE ASSOCIATED MICROFAUNA,
Texas University at Dallas, Richardson.
G. R. Lanza, and W. T. Waller.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1076-1083, June, 1981. 53 Ref.

Descriptors: *Microorganisms, *Literature review, *Toxicity, Water pollution effects, Bibliographies, Chlorine, Oil pollution, Pesticides.

A review is presented of 1980 literature on substrate associated microfauna which includes a section on papers dealing with toxicity studies. Respiration at two temperatures of two species of freshwater leech exposed to chlorine were studied. The use of Chilomonas paramecium populations in acute toxicity testing was evaluated, and the oxygen uptake in freshwater planaria exposed to various pesticides was studied. The sensitivity of 12 species of marine ciliates to high thermal stress was studied. The effects of crude oil on the Red Sea coral Stylophora pistillata were studied in the laboratory, and 500 potential pollutants were tested on bacteria, green algae, and protozoa. One study monitored stream pollution using protozoan communities and artificial substrates. The effect of the Cadiz oil spill on selected meiofauna was determined, and another study considered the effects of alkanes from the Buccaneer oil field in the Gulf of Mexico on benthic organisms. Other reports discussed the sampling, preservation, and physiological characterization of substrate-associated microfauna in aquatic systems. The structure, function and colonization patterns of substrate-associated microfauna as affected by ecological factors are also reviewed. (Small-FRC)
W82-01283

DISEASE OUTBREAKS CAUSED BY DRINKING WATER,
Harvard School of Public Health, Boston, MA.
G. F. Craun.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1134-1138, June, 1981. 39 Ref.

Descriptors: *Diseases, *Drinking water, *Pathogens, Reviews, Water pollution sources, Water pollution effects, Epidemiology, Public health, Human diseases, Infection, Water treatment, Poisons, Giardiasis, Cooling water, Viruses, Bacteria, Parasites.

Disease borne by drinking water caused 2 deaths and 48,193 cases of Illness in the U.S. during 1971-78. Of the 224 outbreaks of disease, 58% were in non-community water systems. However, most cases of illness (69%) resulted from problems in community water systems. Contamination of distribution systems was responsible for 38% of the outbreaks, and treatment deficiencies, for 33%. Cases of chemical poisoning involved a cross connection between a ship's drinking water system and the photographic developing machines and several incidents of excessive fluoride addition in water treatment systems. Giardia lamblia was the most frequently encountered pathogen, and outbreaks of waterborne giardiasis have been increasing in frequency. Most have occurred in systems using surface water with chlorination as the only treatment. Studies of a gastroenteritis outbreak at Crater Lake National Park in 1975 showed 5 cases of hepatitis A in 2206 persons exposed and not given immune serum globulin, but this was not statistically significant. On a national level waterborne hepatitis A amounts to 35-120 average annual cases, or 1% of the annual reported hepatitis A cases. Other outbreaks of waterborne disease were caused by toxigenic E. coli on a cruise ship, a water humidification system in a large factory, Legionella pneumophila in cooling and air conditioning systems, and nontuberculous myobacteria in the southeastern U.S. (Cassar-FRC)
W82-01289

WATER CHARACTERISTICS,
Army Construction Engineering Research Lab. (Army), Champaign, IL.
For primary bibliographic entry see Field 5B.
W82-01305

INFLUENCE OF PCBS IN WATER ON UPTAKE AND ELIMINATION OF DDT AND DDE BY LAKE TROUT,
National Marine Fisheries Service, Ann Arbor, MI. Great Lakes Fishery Lab.
R. J. Hesselberg, and L. W. Nicholson.
Journal of Environmental Quality, Vol 10, No 3, p 315-318, July-September, 1981. 1 Fig, 2 Tab, 13 Ref.

Descriptors: *Polychlorinated biphenyls, *DDT, *Trout, Water pollution effects, Pollutants, *Lake Michigan, DDE, Fish, Sublethal effects, Pesticides, Chlorinated hydrocarbons, Bioaccumulation, Metabolism.

Several species of fish in Lake Michigan, particularly lake trout, were heavily contaminated with DDT and its metabolites during the 1960s. Although DDT was banned in the states bordering the lake in 1970, researchers predicted that more than a century would be needed to reduce DDT contamination below detectable levels. However, by 1976, residues of total DDT in lake trout from Lake Michigan had declined from 10.5 micrograms per gram in 1970 to 5.7 micrograms per gram. The detection of relatively high concentrations of polychlorinated biphenyls (PCBs) in lake trout tissues during this period led to the hypothesis that uptake and elimination of DDT and DDE by the fish may have been influenced by the accumulation of PCBs in the fish. Fingerling lake trout were exposed to various combinations of DDT and DDE (100 nanograms per liter) and PCBs (100 and 500 nanograms per liter) in water for 12 weeks in order to determine what, if any, effect PCBs had on the uptake or elimination rates of DDT and DDE. PCB exposure was continued for an additional 16 weeks after completion of exposures to DDT and DDE in order to measure any effect the PCBs might have on DDT and DDE elimination by the fish. Comparison of the DDT and DDE accumulation and elimination rates showed that PCBs did not influence these processes in lake trout. These results indicate that the decline of DDT and DDE in fish from Lake Michigan is not related to the presence of PCBs, but actually reflects a decrease in the amount of these contaminants available to the fish from the food or water. (Carroll-FRC)
W82-01342

A HYDROBIOLOGICAL SURVEY OF A POLLUTED CANAL,
Baghdad Univ. (Iraq). Dept. of Biology.
M-B. M. Mohammad.
Hydrobiologia, Vol 74, No 2, p 179-186, September, 1980. 6 Fig, 1 Tab, 24 Ref.

Descriptors: *Water quality, *Wastewater disposal, *Aquatic life, *Water pollution effects, *Qanat Al-Jaish Canal, *Iraq, Canals, Benthic fauna, Invertebrates, Macroinvertebrates.

The chemical, physical, and biological aspects of the 23.5 km long, 25 meters wide, and 1.5 meters deep Qanat Al-Jaish canal, Baghdad, Iraq, is documented. The canal receives wastewater from the Jamila residential quarter and contains a variety of waste and refuse. Sampling at 4 stations over a 12-month period starting February 1978 showed that species diversity of net aquatic life varied inversely with the degree of pollution as measured by BOD (3.2-20 mg pr liter). In the benthos, diversity indices increased with increases in amounts of silt and organic detritus. Fauna in the canal consisted of 41 species in 6 phyla, arranged in order of abundance: Arthropoda, Annelida, Aschelminthes, Mollusca, Platyhelminthes and Rhynchocoela. The indices of diversity were not directly related to concentrations of phosphate (6.0-8.5 mg per liter), nitrite (0.3-0.46 mg per liter), ammonia (0.55-0.79 mg per liter), temperature (11-31 degrees C), oxygen content (0-9 mg per liter), chloride (70-130 mg per liter), hardness (400-600 mg per liter), pH (7.0-7.9), Secchi disk transparency (0.1-0.7 meters), and water velocity (0.5-1.3 meters per sec). The waste stream entering the canal contained no macroscopic animals except for the pollutant-resistant tubificid worm, Limnodrilus. The waste stream, with high levels of salts and low levels of dissolved oxygen, raised the canal BOD from 5 mg per liter to 11-20 mg per liter, with a reduction to 10-15 mg per liter within 14 km downstream. (Cassar-FRC)
W82-01356

MINING POLLUTION AND THE DIET OF THE PURPLE-STRIPED GUDGEON MOGURNDA MOGURNDA RICHARDSON (ELEOTRIDAE) IN THE FINNISS RIVER, NORTHERN TERRITORY, AUSTRALIA,
Australian Atomic Energy Commission Research Establishment, Lucas Heights.
R. A. Jeffree, and N. J. Williams.
Ecological Monographs, Vol 50, No 4, p 457-485, December, 1980. 5 Fig, 15 Tab, 102 Ref.

Descriptors: *Mine drainage, *Fish, *Diets, Heavy metals, Sulfate, Mine wastes, Industrial wastes, Aquatic animals, Toxicity, *Finniss River, *Australia, Water pollution effects, Eleotridae, Abandoned mines, Copper mines, Uranium mines.

The diet of the freshwater eleotrid Mogurnad mogurnda Richardson in the Finniss River, Australia, was investigated, and pollutants in the river were determined which reach the river from Rum Jungle, an abandoned uranium/copper mining area. The pollutant discharge contained large amounts of copper, zinc, manganese, and sulfate at low pH values. The fish ate high abundances of animals of the taxa Dytiscidae, Chironomidae, Ceratopogonidae, Trichoptera, Odonata, Copepoda, and Pisces. Five foods were more abundant in the diets of the polluted zone, and three in those of the unpolluted zone. Two categories of foods were contrasted for their usefulness in distinguishing between the zones by both hierarchical agglomerative and discriminant function analysis. Aquatic respirers were more effective than those obtaining oxygen directly from the atmosphere or via a film or bubble of air. The relevance for pollution studies of dietary analysis rather than sampling fauna directly is discussed in terms of food substitution,

switching, strategies for abundance and recovery by the fauna, and possible effects of pollutants on the fish as an intervening collector. (Small-FRC)
W82-01366

EVALUATION OF THE POLLUTED RIVER SAVINJA WITH THE HELP OF MACROPHYTES,
Ljubljana Univ. (Yugoslavia). Biological Inst.
D. Vrhovsek, A. Martincic, and M. Kralj.
Hydrobiologia, Vol 80, No 2, p 97-110, May, 1981. 6 Fig, 7 Tab, 23 Ref.

Descriptors: *Monitoring, *Pollution load, *Rivers, Environmental protection, Water pollution control, *Savinja River, *Yugoslavia, Saprophytic bacteria, Oligotrophy, Trophic level, Mesotrophy, Aquatic plants, Water quality, Water pollution effects.

The influence of inorganic and organic pollution on the river Savinja, Slovenia, a typical Alpine river in its upper part and a lowland river in its lower part, was evaluated with the help of macrophytes. Mosses were particularly helpful in quantitative estimations of the percentage of their coverage and species composition. All other emersal and submersal plants were also listed and included in the qualitative interpretations of the degree of saprobicity. Qualitative and percentile composition was investigated at nine points along the Savinja river, chosen with the intention of determining gradual changes in macrophyte growth on account of the water current and the influence of individual pollutants. With the aid of species composition and stages of saprobicity, the Savinja can be divided into segments. The upper part is oligosaprobic, from Celje to Lasko beta mesosaprobic, and to the river's mouth alpha-beta mesosaprobic. When comparing the concentrations of some ions it was determined that they do not surpass the toxic levels and therefore the differences in species content are not the result of ion concentrations, but rather of the synergistic effects with other types of pollution. (Baker-FRC)
W82-01377

THE EFFECT OF POLLUTANTS FROM THE COAL INDUSTRY ON THE FISH FAUNA OF A SMALL RIVER IN THE SOUTH WALES COALFIELD,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
J. Scullion, and R. W. Edwards.
Environmental Pollution (Series A), Vol 21, No 2, p 141-153, February, 1980. 3 Fig, 5 Tab, 38 Ref.

Descriptors: *Fish populations, *Mine wastes, *Coal mines, *Acid mine drainage, Water pollution effects, Toxicity, Rivers, Trout, Iron, Mine drainage, Acid streams, Suspended solids, Silting, Water quality, Invertebrates, Fish food organisms, Population density, Taff Bargoed, *Wales.

The Taff Bargoed, a river in south Wales, receives pollution from coal mine sources at three separate locations: acid drainage from coal stockpiles in the headwaters, pumped mine water containing high levels of silt, and ferruginous drainage of neutral pH from old mine workings. Brown trout (Salmo trutta) populations and water quality were studied at 11 stations in the river. Trout density was very low, less than 0.05 per sq meter, downstream of acid and ferruginous drainage, in the latter cases as a result of poor invertebrate food supplies rather than toxic water. In the silty water, average suspended solids 100 mg per liter, trout densities of less than 0.15 per sq meter were found, and the fish were in poorer condition. Trout eggs had 85-87% hatching rates in unpolluted water, 1.3% downstream of the silty mine water and 13.3% downstream of the ferruginous drainage. The stoneback (Noemacheilus barbarulus L.) was reduced in density at the silted stations. Bullhead (Cottus gobio L.) has been essentially eliminated since 1969, probably as a result of the acid water. Minnows (Phoxinus phoxinus L.) were only found in the upper and middle reaches of the river and in patchy distribution. Eels (Anguilla anguilla L.) were absent from the upper reaches and rare elsewhere. (Cassar-FRC)
W82-01389

ABATE: EFFECTS OF THE ORGANOPHOSPHATE INSECTICIDE ON BLUEGILLS AND INVERTEBRATES IN PONDS,
Columbia National Fisheries Research Lab., MD.
H. O. Sanders, D. F. Walsh, and R. S. Campbell.
Technical Papers of the U.S. Fish and Wildlife Service, No 104, 1981. 8 p, 3 Fig, 3 Tab, 11 Ref.

Descriptors: *Organophosphorus pesticides, *Toxicity, *Insecticides, *Bluegills, *Invertebrates, Growth, Immature growth stage, Fish food, Biomass, Larvicides, Aquatic insects, Enzymes.

The organophosphate insecticide Abate is used for controlling larvae of mosquitoes and black flies. In view of the possible broad use of Abate in different geographical locations, an attempt was made to evaluate the effects of this insecticide on pond fish and aquatic invertebrates. Application of Abate three times (at about montly intervals) to duplicate 0.04 ha earthen ponds at 18 g/ha (the recommended application rate) and 180 g/ha caused no mortality of bluegills. In ponds treated with 18 g/ha, fewer bluegill fry were produced than in control ponds, brain acetylcholinesterase activity was not affected, and accelerated growth of both fry and adults appeared to result from heavy feeding on dead or moribund Diptera larvae that resulted from each of the first two applications. In ponds treated with 180 g/ha, ovary development in bluegills was initially faster than in bluegills from control ponds, the number of fry produced per female was lower than in control ponds, brain acetylcholinesterase activity in bluegills was strongly inhibited after the second and third treatments, and biomass of Diptera in the ponds was reduced about 40%, but other invertebrates were unaffected. The routine use of Abate at the recommended rate should have little adverse effect on fishery resources. (Moore-SRC)
W82-01445

ENVIRONMENTAL IMPACT AND HEALTH EFFECTS OF WASTEWATER CHLORINATION,
Illinois Univ. at the Medical Center, Chicago, IL. School of Public Health.
For primary bibliographic entry see Field 5D.
W82-01451

THE EFFECT OF FERTILIZATION WITH PHOSPHORUS AND NITROGEN VERSUS PHOSPHORUS ALONE ON EUTROPHICATION OF EXPERIMENTAL LAKES,
Fisheries and Marine Service, Winnipeg (Manitoba). Freshwater Inst.
D. W. Schindler.
Limnology and Oceanography, Vol 25, No 6, p 1149-1152, November, 1980. 3 Fig, 1 Tab, 13 Ref.

Descriptors: *Nutrients, *Eutrophication, *Phytoplankton, Nitrogen compounds, Phosphorus compounds, *Lakes, Fertilizers, Chlorophyll, Water pollution effects, Ice, Productivity.

A paper by Fee (1979) (See W80-02462) on the relation between lake morphometry and primary productivity and its use in interpreting whole-lake eutrophication experiments was criticized on several points. An erroneous conclusion was drawn that the fertilization of a lake with both P and N caused larger increases in chlorophyll than fertilization with P alone. In addition, phosphorus inputs were uncorrected, and no allowance was made for a lag in phytoplankton response to changes in a lake's loading regime. Furthermore, it was erroneous to state that winter disposal apparently only slightly reduced the effect of nutrient additions. The author of these comments concluded that in the experimental lakes under investigation, which are near equilibrium in P loading, chlorophyll concentrations are not dependent on the amount of N added. P loading, corrected for water renewal, accounted for 80% of the variance in chlorophyll regardless of N:P ratio in the loading. Removal of nutrients under winter ice or into the hypolimnion greatly reduces chlorophyll concentration. (Cassar-FRC)
W82-01457

COMPARISON OF FIRST-ORDER ERROR ANALYSIS AND MONTE CARLO SIMULATION IN TIME-DEPENDENT LAKE EUTROPHICATION MODELS,
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
For primary bibliographic entry see Field 2H.
W82-01460

ORGANIC CONTAMINATION OF GROUND WATER: TELL IT ALL,
Dedham Water Co., MA.
P. Burdan.
Journal of the New England Water Works Association, Vol 95, No 2, p 109-118, June, 1981. 4 Fig.

Descriptors: *Public relations, *Water conservation, *Groundwater pollution, *Water supply, Water conveyance, Public opinion, Public health, *Dedham, Massachusetts, Trichloroethane, Trichloroethylene, Water demand, Water pollution.

The community relations effort by the Dedham Water Company in Massachusetts after about 30% of the total water supply was lost due to organic contaminants is described. Increased consumer understanding of the problem facing the water company resulted in better community cooperation. The potential for customer water demand to exceed the available supply of 50 mgd over the Memorial Day weekend made necessary a general meeting with municipal and state officials, and the use of newspapers, radio, and television. The initial information released to the public told of the steps leading to the discovery of trichloroethane and trichloroethylene contamination, the attempts to determine the source of contamination, the adverse impact on total water supply by having to remove two wells from service, the type of restrictions placed on water use, and the steps the utility was taking to restore full service to customers. A data sheet on the company was also made available. A letter was also mailed to 11,500 customers. The program was successful in reducing water demand to the required levels. (Small-FRC)
W82-01474

THE INTERACTION OF TREATED BLEACHED KRAFT MILL EFFLUENT AND DISSOLVED OXYGEN CONCENTRATION ON THE SURVIVAL OF THE DEVELOPMENTAL STAGES OF THE SHEEPSHEAD MINNOW (CYPRINODON VARIEGATUS),
Academy of Natural Sciences of Philadelphia, PA. Benedict Estuarine Research Lab.
W. C. Graves, D. T. Burton, L. B. Richardson, and S. L. Margrey.
Water Research, Vol 15, No 8, p 1005-1011, August, 1981. 6 Tab, 41 Ref.

Descriptors: *Pulp wastes, *Dissolved oxygen, Fish, *Fish toxins, Kraft mills, Pulp and paper industry, Industrial wastes, Ecological effects, Growth stages, Water pollution effects.

The interaction of various dissolved oxygen concentrations on the acute toxicity of treated bleached kraft mill effluent (BKME) was investigated using sheepshead minnow: embryos, fry, juveniles, and adults. The comparative sensitivity among developmental stages was determined. The interaction between dissolved oxygen concentration and effluent toxicity was assessed by exposing the organisms to a complete composite design in a 3 x 3 factorial matrix with two replicates per cell. Nominal effluent test concentrations were 0, 50 and 100%, and nominal DO concentrations were 1.0, 3.0, and 5.0 mg/liter. Effluent concentration influenced embryo survival, but there was no reaction to DO concentration. The survival of fry was related to DO concentration, with no interaction with BKME concentrations up to 100%. Juvenile minnows demonstrated increased sensitivity to BKME at a nominal DO concentration of 1.0 mg/liter. BKME did not affect adult fish under any of the conditions tested. Thus, the toxicity of BKME to the minnow is a function of developmental stage and DO concentration. (Small-FRC)
W82-01494

EFFECT OF COPPER ON NITRIFICATION IN ACTIVATED SLUDGE,
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
F. Braam, and A. Klapwijk.
Water Research, Vol 15, No 9, p 1093-1098, September, 1981. 10 Fig, 3 Tab, 10 Ref.

Descriptors: *Copper, *Nitrification, *Activated sludge, Hydrogen ion concentration, Nitrilotriacetic acid, Bacteria, Microorganisms, Heterotrophic bacteria, Toxicity, Water pollution effects.

The nitrification rate in activated sludge was affected by the free copper concentration in bath experiments. In turn, the free copper concentration was influenced by pH, sludge concentration, and the presence of nitrilotriacetic acid (NTA). Free copper concentrations increased with decreases in pH. For example, with 9.13 times 10 to the minus 5th power mol Cu per liter the free copper concentration was 4.0 times 10 to the minus 7th power mol per liter at pH 6.5 and 10 to the minus 8th power mol per liter at pH 8.4. At constant pH, free copper concentrations as a function of added copper were greater at 0.7 g per liter of mixed liquor suspended solids than at 1.4 g per liter. Extending the copper exposure period from 1 day to 3 days did not improve the nitrification rate; the organisms did not acclimatize to copper. Addition of NTA, a strong copper-complexing agent, allowed recovery of the nitrification rate; the longer the interval between copper addition and subsequent NTA addition, the longer the recovery time. Nitrifying bacteria were no more or less sensitive to copper toxicity than were heterotrophic microorganisms. (Cassar-FRC)
W82-01497

THE EFFECTS OF A NEW RESERVOIR ON THE ATTACHED DIATOM COMMUNITIES IN HUNTINGTON CREEK, UTAH, U.S.A.,
Brigham Young Univ., Provo, UT. Dept. of Botany and Range Science.
For primary bibliographic entry see Field 2H.
W82-01521

ENVIRONMENTAL RECOVERY IN A MARINE ECOSYSTEM IMPACTED BY A SULFITE PROCESS PULP MILL,
Victoria Univ. (British Columbia).
For primary bibliographic entry see Field 5B.
W82-01548

THE EFFECTS OF ORGANOPHOSPHORUS PESTICIDES ON ESTUARINE AMMONIUM OXIDIZERS,
University of West Florida, Pensacola. Dept. of Biology.
R. D. Jones, and M. A. Hood.
Canadian Journal of Microbiology, Vol 26, No 11, p 1296-1299, 1980. 3 Fig, 1 Tab, 11 Ref.

Descriptors: *Organophosphorus pesticides, *Ammonium, *Pesticides, Water pollution effects, Insecticides, Methyl parathion, Parathion, Guthion, Fonofos, EPN, Abate, Dicapthon, Phenols, Sediments, *Estuarine environment, Oxidation, Nitrites, Anaerobic conditions, Aerobic conditions, Aquatic bacteria, Bacteria, Microbial degradation.

The effects of seven organophosphate pesticides and their degradation products on ammonium oxidation (nitrate formation) in the estuarine environment were studied with pure compounds in axenic cultures, with pure compounds in natural sediment populations, and with aged pesticides in axenic cultures. Ammonium oxidation inhibition at the level of 10 mg per liter pesticide was less than 1% for methyl parathion, EPN, guthion, and dicapthon; 3% for abate; 5% for parathion; and 32% for fonofos. Inhibitions by degradation products of methyl parathion at 10 mg per liter were: methyl paraoxon, zero; p-nitrophenol, 25%; and p-aminophenol, 100%. Nitrite inhibition by 10 mg per liter pesticides and degradation products in natural sediments varied with time of incubation. Guthion, fonofos, methyl parathion, and parathion cultures were almost completely inhibited by day 14, but some showed increased temporary activity about day 9. In aging studies using methyl parathion, parathion, and guthion nitrite production (in mg nitrite-N per liter) was as follows: unaged-84.1-86.0; aerobic conditions-control 83.7, pesticides, 74.4-75.4; static aeration--control 88.4, pesticides, 69.2-77.9; and anaerobic conditions--control, 35.4, pesticides 24.5-27.3. Data suggest that parent compounds have little effect on ammonium oxidation in estuarine sediments, but certain pesticide metabolites may reduce ammonium oxidation, especially under anaerobic conditions. (Cassar-FRC)
W82-01567

ACID PRECIPITATION: BASIC PRINCIPLES AND ECOLOGICAL CONSEQUENCES,
North Carolina State Univ. at Raleigh.
E. B. Cowling, and C. B. Davey.
Pulp and Paper, Vol 55, No 8, p 182-185, August, 1981. 25 Ref.

Descriptors: *Acid rain, *Pulp and paper industry, *Forests, Water pollution effects, Ecological effects, Air pollution, Aquatic life, Soil chemistry, Heavy metals, Nutrient loss, Water quality.

The pulp and paper industry is involved with both the cause and effects of acid precipitation. It is responsible for small, but locally important, emissions, and it owns a significant share of forest land impacted by this pollution. Although significant quantities of desirable plant nutrients (nitrogen and sulfur) are added to the forest system by precipitation, the acidity and its determental effects may outweight the benefits. Damage to the ecosystem is most likely to occur when major inputs of acid precipitation coincide with sensitive stages of a life form (such as fish eggs and larvae), and in poorly buffered, noncalcareous soils and rocks. In the laboratory and field, many biological effects of acid precipitation have been demonstrated--necrotic lesions on foliage, nutrient loss from foliar organs, reduced resistance to pathogens, accelerated erosion of waxes on leaf surfaces, reduced rates of decomposition of leaf litter, inhibited formation of terminal buds, increased seedling mortality, and heavy metal accumulation. Soil microbiological processes such as nitrogen fixation, mineralization of forest litter, and nitrification of ammonium compounds are inhibited, the degree depending on degree of cultivation and soil buffering capacity. Water quality is impacted by contact with vegetation, soil, and bedrock. Acid precipitation mobilizes cations, especially the toxic Al, Mn, and Zn, and nutrients, K, Ca, and Mg. (Cassar-FRC)
W82-01586

STRATEGIES OF RESPONSE TO COPPER, CADMIUM, AND LEAD BY A BLUE-GREEN AND A GREEN ALGA,
Ottawa Univ. (Ontario). Dept. of Biology.
V. M. Laube, C. N. McKenzie, and D. J. Kushner.
Canadian Journal of Microbiology, Vol 26, No 11, p 1300-1311, 1980. 7 Fig, 6 Tab, 33 Ref.

Descriptors: *Algae, *Heavy metals, *Toxicity, Water pollution effects, Fate of pollutants, Chlorophyta, Cyanophyta, Growth rates, Food chains, Metals, Copper, Cadmium, Lead, Eutrophication, Nitrilotriacetic acid, Chelation, Accumulation, Sediments, Ecological effects.

Interactions between algae and heavy metals varied with the type of algae and the metal. Heavy metal ions, Cu(2+), Cd(2+), and Pb(2+), inhibited growth of the cyanophyte, Anabaena strain 7120, and the chlorophyte Ankistrodesmus braunii. Complete inhibition was observed at 0.0001 and 0.001 M Cu and Cd, and a lag in growth at lesser concentrations. In 0.0001, 0.00001, and 10 to the minus 8th power M Pb, cells grew as well as controls. Intermediate Pb concentrations of 10 to the minus 6th power and 10 to the minus 7th power were more inhibitory than some higher concentrations because of precipitate formation at concentrations higher than 0.00001 M. Addition of the chelating agent nitrilotriacetic acid did not protect the algae from metal toxicity. In Anabaena 7120 lysis occurred in early but not late stages with Cu; the other metals did not cause lysis. A. braunii cells were not lysed by any of the metals. Anabaena 7120 growing in 0.00001 M Cu did not accumulate Cu within the cell, but about half the Cd was cell-associated in Anabaena cells growing in 0.00001 M Cd. A. braunii bound substantial amounts of Cu and Cd during growth in metal ion solutions. When algae were grown over dialysis sacs containing sediment with 100 ppm Cu(2+) or Cd(2+), metals were mobilized from the sediment and accumulated in the A. braunii cells and culture medium. In Anabaena 7120 cultures, Cd removed from the sediment was found in cells and culture medium, but Cu was associated entirely with the culture medium. Large algal blooms could be a significant factor in accumulating toxic metals from the water and sediments and thus entering the food chain. (Cassar-FRC)
W82-01598

5D. Waste Treatment Processes

RECLAMATION OF WASTEWATER WITH A SOIL-TURF FILTER: I: REMOVAL OF NITROGEN,
Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.
E. L. Anderson, I. L. Pepper, and W. R. Kneebone.
Journal of the Water Pollution Control Federation, Vol 53, No 9, p 1402-1407, September, 1981. 2 Fig, 7 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Filtration, Filtered wastewater, Clay, Sand, Nitrogen, Filter media, Water quality, *Soil-turf filter.

Maximum rates at which secondary treated wastewater could be applied to a soil-turf filter without harming the turf and still yield leachate averaging less than 10 mg/liter nitrate-nitrogen were determined. Two lysimeter units were filled with 95% sand, 1% silt, and 4% clay. Ten others were filled with 89% sand, 5% silt, 4% clay, and 2% organic matter. Both soils had a pH of 8.3. All plots were seeded to bermudagrass. Overseeded annual ryegrass was grown during cooler seasons. Plots were drip-irrigated with secondary wastewater twice a week. Secondary treated wastewater was obtained from the Randolph Park Sewage Treatment Plant. Nitrogen in the wastewater varied seasonally from 3 to 23 mg/l ammonium-nitrogen, from 0.5 to 16 mg/l nitrate nitrogen, and from 1 to 5 mg/l organic nitrogen. During the first 6 weeks of the study less than 10% of the applied N was recovered in leachates. These initial high removal values were probably the result of ammonium adsorption in the soil and high turf grass use, as plots had not been fertilized for 3 months prior to the study. Stepwise regression equations showed that predictions of nitrate-nitrogen concentration in leachate could be based mainly on the rate of wastewater application. Season and dry weight yield of turf clippings were also important factors. In summer the sand-turf filter could renovate a maximum 12.7 cm/week, yielding 9 cm/wk recharge, compared to 18.7 cm/wk, yielding 12.5 cm/wk recharge for the mix-turf filter. Selection of soils with a higher clay content would increase purification of the wastewater, but decrease the volume of recharge water. (Baker-FRC)
W82-01101

RECLAMATION OF WASTEWATER WITH A SOIL-TURF FILTER: II: REMOVAL OF PHOSPHORUS, BORON, SODIUM AND CHLORINE,
Arizona Univ., Tucson. Dept. of Soils, Water, and Engineering.
E. L. Anderson, I. L. Pepper, W. R. Kneebone, and R. J. Drake.
Journal of the Water Pollution Control Federation, Vol 53, No 9, p 1408-1412, September, 1981. 2 Fig, 6 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Filtration, Filtered wastewater, Filter media, Sodium, Calcium, Magnesium, Boron, Phosphorus, Chlorine.

This paper discusses the removal and potential hazards of phosphorus, boron, sodium, and chlorine from wastewater secondarily treated by means

of a soil-turf filter. Ten lysimeters were filled with sand, and ten were filled with mix. Plots were drip-irrigated with secondarily treated wastewater at high loading rates. Lysimeter leachate was collected and analyzed. As the rate of application of wastewater increased, leachate P concentrations significantly increased. Once the soil became saturated with P, more P remained in solution. For recharge purposes, application rates of wastewater to the soil-turf filter were limited primarily by leachate nitrate concentrations currently determined by the US EPA. Summer values were 12.7 cm/wk for the sand-turf fiter compared to 18.7 cm/week for the mix-turf filter. Corresponding winter values for sand and mix were 13.6 and 21.9 cm/wk, respectively. Boron as borate is not retained by a soil-turf filter because it is an anion and not held by exchange sites, nor is it easily precipitated in the soil. Hence leachate concentrations of B were similar to those of wastewater. Sodium was not removed by a soil-turf filter, but in itself is unlikely to be a human health hazard of the reclamation process. Chlorine concentrations were generally low due to sunlight-induced degradation of chlorine during aerated lagoon storage of wastewater. Overall, the reclamation system described would seem to have good potential for reducing water deficits in the southwestern US. (Baker-FRC)
W82-01102

BACTERIA: MAN'S ALLIES IN WATER POLLUTION CONTROL,
China Features, Beijing (China).
H. Lin.
Environmental Management, Vol 4, No 4, p 285-286, July, 1980. 1 Fig.

Descriptors: *Chemical wastes, *Bacteria, *Biodegradation, *Water pollution control, Wastewater treatment, Industrial wastewater, Organic compounds, Degradation, Ponds, Fish, Aquatic animals, Toxicity, Ya'er Lake, *China.

Bacteria were used to treat organic chemical manufacturing wastes in a series of three purification ponds before entering the 7000 hectare Ya'er Lake, Hubei Province, People's Republic of China. The first and second ponds, 100 ha each, use the native pond bacteria to decompose the organic wastes for 100-120 days, during which 80-90% of the pollution is eliminated. Fish in the third pond, 210 ha, are healthy and show no abnormalities. Water from this pond enters the lake pollution-free. Prior to 1976, when this treatment system was built, the few fish and shrimp surviving in the polluted lake were not fit for human consumption. The methods developed here have been applied to other industrial wastewaters as well. (Cassar-FRC)
W82-01158

DEMONSTRATION TESTING OF ALUM RECOVERY BY LIQUID ION EXCHANGE,
Michigan State Univ., East Lansing. Dept. of Civil Engineering.
D. A. Cornwell, G. C. Cline, J. M. Przybyla, and D. Tippin.
Journal of the American Water Works Association, Vol 73, No 6, p 326-332, June, 1981. 12 Fig, 7 Tab, 6 Ref.

Descriptors: *Ion exchange, *Alum, *Sludge conditioning, Coagulation, Water treatment, Pilot plants, *Tampa, Florida.

A pilot plant for alum recovery from water treatment sludge by liquid ion exchange was operated at the Tampa, Florida, Hillsborough River plant. The major components of the 0.63 liter per sec system were sludge collection and feed, extraction, stripping, and residual sludge treatment. Both types of mixing, rapid and slow, recovered more than 90% of the alum. It is predicted that the full-scale plant would have a similar recovery. The solvent consisted of 15% volume to volume octyl acid phosphate, 2% tributyl phosphate, and 83% petroleum solvent (Kermac 627). Of the two process flow schemes the contactor performed better than the mixer-settler. The contactor was easier to operate, did not produce phase inversion or raffinate entrainment in the extract, and had a much smaller bleed solids stream requiring solvent recovery. However, the contactor required a longer detention time and was more expensive to construct. The quality of the recovered alum was similar to that of the commercial alum. There was no significant buildup of Ba, Na, Cu, Cr, Mg, Mn, or Ag. Zn and Pb were extracted at low concentrations, and the metal concentrations in the recovered alum were in the same range as in the commercial alum. Total organic carbon was 206 mg per liter, compared with 100 mg per liter in commercial alum. Recovered alum contained 34 g per liter Al(3+), but when adjusted to 17.1% Al_2O_3, jar test results were identical for recovered and commercial alum. The sludge showed a 50% reduction and readily settled to a 10% solids concentration. (Cassar-FRC)
W82-01167

ADVANCED WASTEWATER PLANT IS ENERGY SAVER,
Capital Consultants, Inc., Lansing, MI. Industrial and Environmental Div.
R. T. Beaupre, W. T. Harvey, and J. R. Marry.
Water/Engineering and Management, Vol 128, No 8, p 30-33, August, 1981. 1 Fig, 2 Tab.

Descriptors: *Biological wastewater treatment, *Wastewater treatment facilities, *Treatment plants, Gravity filters, Aeration, Ammonia, Biochemical oxygen demand, Energy, Economic aspects, *Advanced wastewater treatment.

A new advanced wastewater treatment plant built for Charlotte, Michigan, uses rotating biological disc units. The secondary treatment system consists of 12 electro-mechanically driven rotating biological discs. The primary and secondary processing was designed to remove 90% BOD5 and suspended solids and 95% ammonia at an average wastewater flow of 1.2 mgd. Outdoor concrete tanks with mixed media beds, precast concrete underdrains, water surface wash, and pneumatic controls make up the gravity filters. A reaeration systems ensures a minimum of 5.0 mg/liter of dissolved oxygen in the final effluent. The sludge digestion system is a high-rate, two-stage system which generates digester gas. Primary heating for the control building is provided by three water-to-air heat pumps which operate with the chlorinated final effluent. These heat pumps provide heating, ventilation, dehumidification, and cooling. The low bid for construction of the facility was $4,895,000, and the plant was completed in August 1980. (Small-FRC)
W82-01177

A SUCCESSFUL LOW TECHNOLOGY WASTEWATER PROCESS,
Donohue and Associates, Inc., Sheboygan, WI. Environmental Div.
P. P. Stecker.
Water/Engineering and Management, Vol 128, No 8, p 46, 47, 49, August, 1981. 2 Fig.

Descriptors: *Filtration, *Sand filters, *Seasonal variation, Wastewater treatment, Performance evaluation, Recreation wastes, Economic aspects, Biochemical oxygen demand, Nitrification, Lake Michigan, Barleys Harbor, *Wisconsin.

A circulating sand filtration system was installed in the small resort town of Baileys Harbor, Wisconsin. Activated sludge and rotating biological systems were also considered for the site, but they could not as easily produce a 20 mg/liter effluent, would be more difficult to operate, and would be less able to accomodate the varying wastewater loadings. The recirculating sand filter effluent was discharged to a wetland, as this cost $500,000 less than a Lake Michigan discharge. The system is made up of a septic tank and the intermittent sand filter. The system produces effluent BOD and suspended solids levels of 10 to 20 mg/liter or less, and high levels of 10 to 20 mg/liter or less, and high levels of nitrification are also obtained. Sand with an effective size in the range of 0.25 to 1.5 mm was used in the filter. The system easily handles wide seasonal or weekly variations in wastewater flow. (Small-FRC)
W82-01178

PHARMACEUTICAL COMPANY'S AERATION SYSTEM SAVES ENERGY,
Hoffmann-la-Roche, Belvidere, NJ.
J. S. Brandl.
Industrial Wastes, Vol 26, No 2, p 16, 19, March/April, 1980.

Descriptors: *Wastewater treatment, *Industrial wastes, *Aeration, Aerobic digestion, *Pharmaceutical industry, Mechanical equipment, Activated sludge process, Mixing, Oxygenation, Energy conservation.

An expanded wastewater treatment plant at the Hofmann-la-Roche facility processes all the industrial waste water (about 98%) and the sanitary sewage (about 2%) from the plant's 1000 employees. During periods of rain the entire facility's rooftop surfaces, diked areas, and tank farm drain into the treatment plant. A total of 2 MGD, on the average, flow to the treatment plant, which discharges effluent to the Delaware River within the limits of the EPA NPDES permit. The aeration system is efficient, providing cost savings in electric power. A two-stage activated sludge system functions as the heart of the treatment plant. The wastewater treatment plant is manned 24 hr, seven days a week, by 11 licensed operators. The annual budget to run the plant is in excess of $1,000,000. Wastewater entering the treatment plant has a pH ranging from 2.0 to 12.5, an average temperature of 90 degrees F and an average 5-day BOD of 1,000 mg/liter. The average daily flow is 2 MGD and presently ranges from 1.6 to 2.2 MGD. Grit is removed in a 75,000 gal pre-clarifier, before wastewater enters the equalization ponds. From the primary clarifiers the wastewater enters the two-stage activated sludge process. The flow is nutrient adjusted by adding either ammonium hydroxide or phosphoric acid. All sludges generated are sent to the aerobic digester where detention time is 20-30 days. (Baker-FRC)
W82-01180

HIGH-SOLUBILITY GAS FLOTATION,
Union Carbide Corp., South Charleston, WV. Chemicals and Plastics.
R. A. Conway, R. F. Nelson, and B. A. Young.
Journal of the Water Pollution Control Federation, Vol 53, No 7, p 1198-1205, July, 1981. 7 Fig, 4 Tab, 23 Ref.

Descriptors: *Sludge thickening, *Flotation, *Solubility, Activated sludge, Digestion, Performance evaluation, *Wastewater treatment, Industrial wastes, Separation techniques.

A comprehensive bench-scale evaluation was made of dissolved gas flotation for sludge thickening, comparing air and two potentially available higher solubility gases. The two process gases chosen for comparison with air were an off-gas from an oxygen activated sludge system and combusted digester gas. Flotation tests using each gas were conducted with an industrial recycle sludge, 9900 mg/liter total suspended solids, at R/Q values (ratio of recycle to sludge flow) of 0.11 to 1.5. Another duplicate series was run at R/Q = 0.97 with coagulant addition. Results indicated that the operation of existing dissolved-air systems could be improved by decreasing the recycle flow or increasing the sludge flow. Also, a new flotation system could be smaller and more competitive if high-solubility gases were used. Combusted digester gas was effective at a gas to solids ratio of 0.01 to 0.04, while oxygen activated sludge gas was effective at a gas to solids ratio of 0.04 or greater. (Small-FRC)
W82-01184

ENERGY REQUIREMENT FOR SMALL WASTEWATER TREATMENT SYSTEMS,
Utah State Univ., Logan. Coll. of Engineering.
E. J. Middlebrooks, C. H. Middlebrooks, and S. C. Reed.
Journal of the Water Pollution Control Federation, Vol 53, No 7, p 1172-1197, July, 1981. 15 Fig, 24 Tab, 14 Ref.

Descriptors: *Energy, *Wastewater treatment, *Costs, Economic aspects, Data collections,

Ponds, Infiltration, Overland flow, Secondary treatment.

Energy requirements are summarized for all viable alternatives available for the treatment of flow rates of 190 to 19,000 cu m/day of wastewater. Data are presented in tabular form, and most unit operations and processes can be estimated by combining data. As energy costs increase, they are fast becoming the predominant factor in the selection of small-flow treatment systems. Low energy systems are attractive because they are often easier to maintain and minimize highly skilled operation requirements. The most energy efficient system described is a facultative pond followed by rapid infiltration. If surface discharge is necessary and impermeable soils exist, a facultative pond followed by overland flow is the second most energy efficient system considered. Physical-chemical advanced secondary treatment systems utilize the most energy of conventional systems which meet the federal standard effluent requirements. (Small-FRC)
W82-01185

DATA BASE DEVELOPMENT FOR THE DESIGN OF A RADIUM-226 REMOVAL PROCESS,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
D. W. Averill, P. M. Huck, G. H. Kassakhian, D. Moffett, and R. T. Webber.
Journal of the Water Pollution Control Federation, Vol 53, No 7, p 1233-1242, July, 1981. 6 Fig, 7 Tab, 6 Ref.

Descriptors: *Data collections, *Radium-226, *Chemical precipitation, *Wastewater treatment, Barium, Clarification, Filtration, Pilot plants, Radium radioisotopes.

Benchmark and pilot plant studies were performed on mechanical wastewater treatment systems to remove radium-226 from impoundment area effluents. Two wastewater treatment processes have been evaluated thus far; both of them incorporate barium-radium coprecipitation in series-connected stirred tank reactors. A clarification process included coprecipitation followed by rapid mixing of a chemical coagulant, flocculation in series connected mechanical flocculators, and solids-liquid separation in a clarifier. The other process is a filtration process which includes coprecipitation followed directly by solid-liquid separation using chemically aided granular media filtration. Both processes produced total radium-226 activity levels of less than 0.37 Becquerel/liter and dissolved radium-226 levels approaching or equal to 0.11 Becquerel/liter. The results of these studies make up a preliminary data base on physico-chemical treatment methods for radium-226. The processes will be tested under steady-state conditions. (Small-FRC)
W82-01188

DENITRIFICATION OF BLACKWATER WITH GREYWATER,
Connecticut Univ., Storrs. Dept. of Civil Engineering.
R. Laak, M. A. Parese, and R. Costello.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No EE3, p 581-590, June, 1981. 2 Fig, 3 Tab, 15 Ref. OWRT-A-999-CONN(20), 14-34-0001-0107.

Descriptors: *Denitrification, *Biological treatment, *Domestic wastes, Nitrogen removal, Performance evaluation, *Wastewater treatment, Organic carbon, Wastewater.

A nitrogen removal technique called RUCK is being developed for on-site systems, which will be useful where nitrate pollution from septic tank systems may be a potential problem. It is a biological technique which is passive, energy-free, and requires no more maintenance than a septic tank. The system was field tested for nitrogen removal efficiency at a house site using laundry and sink wastes as the organic carbon source, and at condominiums using the entire greywater flow. Blackwater and greywater flowed into separate septic tanks. Blackwater passed through a subsurface sand bed and then to a rock filter tank, while greywater went straight to the rock filter tank. Final treatment was a seepage bed. Nitrifying reactors of 1.5 ft of concrete-sand media provided a reliable method for the nitrification of blackwater septic tank effluent. Comparable denitrification efficiencies were obtained using either greywater or methanol as a carbon source. When greywater and blackwater are separated, an overall nitrogen removal of over 70% can be achieved. (Small-FRC)
W82-01225

PHYSICAL AND CHEMICAL METHODS,
Florida Univ., Gainesville.
J. Zoltek, Jr., and E. L. Melear.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 679-687, June, 1981. 158 Ref.

Descriptors: *Physicochemical treatment, *Wastewater treatment, Industrial wastewater, Organic compounds, Water reuse, Coagulation, Filtration, Membrane processes, Adsorption, Activated carbon, Ion exchange, Oxidation, Reviews.

New developments in physical and chemical methods of wasteater treatment are reviewed. Water reuse is a reality at several plants. Topics classified under coagulation and solids separation include dissolved air flotation and foam separation. Polymers removed wastewater components in woolscour effluent, kraft liquor, and raw wastewater. Phosphates were precipitated by fly ash extract, alum, iron and aluminum hydroxides, oxygen nitrification, and FeC13-lime. Efficiency and mechanisms of coagulation, sedimentation, and filtration were discussed in about 30 papers. Activated carbon was the most commonly reported adsorption material for wastewater treatment. In addition to theoretical studies, papers describe activated carbon treatment for a variety of organic chemicals and oil refinery wastewater. Other adsorbents mentioned were synthetic resins, sludges, sediments, clays, and peat. Ion exchange systems were used to remove heavy metals, detergents, ammonium, hydrochloric acid, and low molecular weight organic acids. Membrane processes successfully treated waters containing radium, thio salts and metal ions from mining effluents, paraffin oil/water emulsions, polyvinyl alcohol, and inorganic salts inmine water. Suspended solids (60%) and BOD (27%) were removed in a combined sewer system flow by ultra high rate filtration. Air, oxygen, or ozone were used to oxidize various pollutants--hydrogen sulfide, phenols, toxic refractories, nitrilotriacetic acid, cyanide, and surfactants. (Cassar-FRC)
W82-01241

BIOLOGICAL FILTERS,
Brigham Young Univ., Provo, UT.
S. L. Klemetson, and G. L. Rogers.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 687-700, June, 1981. 144 Ref.

Descriptors: *Biological filters, *Rotating biological contactors, *Reviews, *Wastewater treatment, Filters, Trickling filters, Nitrification, Anaerobic conditions, Fluidized beds, Aquaculture.

Rotating biological contactors (RBC) formed the topic of more than half of the recent papers on the subject of biological filters in wastewater treatment. Among the apsects of RBC discussed were: microbial populations, biofouling, kinetics of denitrification, kinetics of nitrification, mathematical models, operating and performance, oxygen transfer, anaerobic RBC, pressurized systems, ferrous iron removal, and treatment of specific wastewaters (explosives, phenol-formaldehyde, aquaculture, chemicals, tanneries, and combined sewer overflows). Fixed biological filters were successfully adapted for many applications. However, problems were experienced in pesticide removal. Fluidized bed reactors were studied theoretically and using models. The most promising adsorbent for removing residual organics was activated carbon. A fluidized bed process removed 95% of the BOD from corn wet milling wastewater. Use in domestic and industrial waste treatment is still in the experimental stage. Anaerobic biological filters treated vegetable tanning effluents, carbohydrate wastes, and wastewaters containing soluble gum, propylene glycol, and caustic soda. Biofilters were used in recirculating filters for aquaculture. The inert media were stone, shells, plastics, sand, and charcoal or combinations of these materials. (Cassar-FRC)
W82-01242

ACTIVATED SLUDGE,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
J. H. Sherrad, D. A. Smith, and J. E. Alleman.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 700-709, June, 1981. 135 Ref.

Descriptors: *Activated sludge, *Industrial wastewater, *Nitrification, *Wastewater treatment, Model studies, Design criteria, Phosphorus removal, Sludge, Microorganisms, Shock loads, Oxygen transfer, Oxygen uptake, Aeration, Activated carbon, Aerobic digestion, Reviews.

A review of recent literature on activated sludge lists mathematical models for analyzing the process. Design concepts and options studied in the laboratory and in pilot plants include determination of sludge age by total solids mass, mutant bacteria for refinery wastewaters, air vs. pure oxygen, continuous vs. intermittent feeding conditions, the deep shaft process, calculation of rotor size based on hydraulic head losses in looped reactors, and rotary biological contactors for supplemental oxidation in activated sludge aeration basins. Responses of activated sludge systems to shock loads and methods of improving performance are discussed. Various workers improved sludge characteristics by using a minimum 2.0 mg per liter dissolved oxygen in a brewery treatment plant, sludge ages of 15-20 days, a stalked bacteria (Caulobacter), growth inhibitors for Sphaerotilis, plug flow, an anoxic mixing stage in the aeration basin, and reduction in longitudinal mixing. Oxygen uptake and transfer is shown to depend on diffuser header pattern and desnsity. Some authors propose oxygen uptake and transfer as a control variable; others state the opposite. Nitrification is the subject of several reviews and many studies. Phosphorus removal for advanced wastewater treatment is accomplished by adding metallic salts to the activated sludge tanks without chemical addition (dependent on COD removal), adding an anaerobic stage, the PHOSTRIP process, and ferrous ion addition. The activated sludge process is used to treat industrial wastewaters containing phenol, coal gasification quench wastes, petrochemical wastes, chemical-pharmaceutical wastes, textile wastes, tannery wastes, food processing wastes, distillery wastes, and brewery wastes. Powdered activated carbon improved the activated sludge process with respect to organic compounds, color, and organic shock loads. (Cassar-FRC)
W82-01243

LAGOONS AND OXIDATION PONDS,
Utah State Univ., Logan.
D. B. George.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 709-711, June, 1981. 14 Ref.

Descriptors: *Oxidation lagoons, *Stabilization lagoons, *Literature review, Bibliographies, Wastewater treatment, Water reuse, Mathematical models, *Lagoons, *Oxidation ponds.

A literature review is presented of publications on lagoons and oxidation ponds published in 1980. Articles fall into the general categories of process performance and biology, upgrading of lagoons, and process models. Connecticut published standards on lagoon systems for the disposal of septage. Several studies dealt with the Dan Region Project, which is the largest and most advanced water reuse scheme in Israel which utilizes oxidation ponds. A study on stabilization ponds in Peru

examined the use of treated wastewater for agricultural purposes. More stringent wastewater treatment plant discharge standards resulted in several studies on upgrading existing lagoons. An in situ method is alum addition, another study investigated water hyacinth, and another evaluated the culturing of fathead minnows. Process models included a biogeochemical model developed to describe the dynamic responses of carbon, nitrogen, phosphorus, and pathogenic contaminants in facultative wastewater stabilization ponds. (Small-FRC)
W82-01244

ANAEROBIC PROCESSES,
Institute of Gas Technology, Chicage, IL.
K. F. Fannin, J. R. Conrad, D. E. Jerger, V. Srivastava, and S. Gosh.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 711-720, June, 1981. 1 Tab, 79 Ref.

Descriptors: *Anaerobic digestion, *Literature review, *Bibliographies, Anaerobic bacteria, Wastewater treatment, Fermentation, Anaerobic lagoons.

A review of the literature published in 1980 is presented for anaerobic processes. Several papers dealt with microbiology, including classification and characterization, cellulose hydrolysis and ethanol production, acidogenesis, and methanogenesis. Papers on process characterization concerned biodegration and biotoxicity, while process optimization and process application were the topics of other publications. A general review was published on the status of research and technology on the conversion of wastes and biomass to various forms of usable energy. Another review of solar and biomass technologies considered applications for cotton ginning residue combustion, etc. Studies on the development and investigation of fermenters were reviewed, and the potential of anaerobic digestion for the conversion of wet biomass to energy was evaluated. A table is presented which summarizes data from the operation and performance of anaerobic digestion studies. (Small-FRC)
W82-01245

DENTRIFICATION,
Greater Chicago Metropolitan Sanitary District, IL.
M. Krup, and B. S. Prakasam.
Journal of the Water Pollution Federation (Literature Review Issue), Vol 53, No 6, p 720-726, June, 1981. 65 Ref.

Descriptors: *Dentrification, *Literature review, *Bibliographies, Nitrogen removal, Nitrogen, Bacteria, Activated sludge process, *Wastewater treatment.

A literature review is presented of publications appearing during 1980 on the topic of denitrification. Papers were published in several areas including slurry processes, attached growth processes, and soil denitrification, and there were several new patents. Bench-scale studies were reported of sequencing batch biological reactors utilizing bacterial storage of raw waste organic components to supply the electron donor needed for denitrification. Studies designed activated sludge units for the removal of nitrogen and phosphorus, and one study reported on the results of an activated sludge system utilizing passes through an aeration tank to treat wastewater. Forty-seven denitrifying bacteria were isolated in one study of a model wastewater treatment system which consisted of two nitrification reactors and clarifiers and three denitrification columns. Environmental factors which affect soil column denitrification were explored, and pilot plant studies were used in one investigation of plant-soil systems to determine the fate of applied N during overland flow. Many patents were obtained for denitrifying systems employing mainly suspended growth systems. (Small-FRC)
W82-01246

ONSITE ALTERNATIVES FOR TREATMENT AND DISPOSAL,
Wisconsin Univ.-Madison.
W. C. Boyle, and R. J. Otis.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 733-737, June, 1981. 48 Ref.

Descriptors: *Literature review, *Bibliographics, *Wastewater treatment, *Underground waste disposal, Septic tanks, *Wastewater disposal, On-site investigations, Sewage disposal, Reviews, Conferences.

A literature review is presented of 1980 publications on the topic of onsite alternatives for wastewater treatment and disposal. It covers the general areas of onsite treatment, subsurface disposal systems, evapotranspiration, septage management, management, and small community facilities. A book was published outlining alternatives for homes, groups of dwellings, and some industrial and commercial establishments. EPA published a comprehensive design manual, and the forty papers presented at the 6th National Conference on Individual Onsite Wastewater Systems addressed state-of-the-art research. Several articles focused on the compost toilet and septic tank design. Subsurface disposal systems were studied, and the attenuation of pollutants in soils, site evaluation, and the performance of soil adsorption systems were addressed. A state-of-the-art review was published on cost effective and environmentally sound alternatives to septage treatment and disposal. As many small communities are interested in alternative treatement, one paper reviewed the role of public and private interests in onsite system management programs. (Small-FRC)
W82-01248

O & M WASTEWATER COLLECTION AND TREATMENT FACILITIES,
Valley Sanitary District, CA.
D. D. Drury.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 737-739, June, 1981. 30 Ref.

Descriptors: *Literature review, *Wastewater collection, *Wastewater facilities, Operating policies, Maintenance, Bibliographies, Activated sludge process, Wastewater treatment.

A literature review is presented of 1980 literature on the operation and maintenance of wastewater collection and treatment facilities. In the area of improving operations, a study of 120 plants concluded that 85 to 90% of the plants were not meeting NPDES discharge permit requirements but could have if appropriate operations and maintenance procedures had been followed. Studies in operating the activated sludge process included one on the deep-shaft activated sludge plant in Marsh Farm, Tilbury, and the startup of an oxidation ditch in winter. Plant startup and operator training studies included a study of the problems associated with fluctuating waste loads. Computer control systems were described in papers on computer aided operations. The effect of the collection system on plant operations was explored in several papers including a survey of 14 treatment plants in Northern California before and during the recent drought. Other papers on operation and maintenance included some on the maintenance problems caused by the eruption of Mount St. Helens. (Small-FRC)
W82-01249

DISINFECTION,
Georgia Inst. of Tech., Atlanta.
J. P. Gould, and C. N. Haas.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 739-748, June, 1981. 2 Tab, 154 Ref.

Descriptors: *Disinfection, *Literature review, *Chlorination, *Ozonation, Trihalomethanes, Environmental effects, Water treatment, *Wastewater treatment, Bibliographies, Carcinogens.

A literature review is presented of 1980 publications dealing with disinfection of water and wastewater. Two tables are included: the first on inactivation of various microorganisms by chlorine, and the second on inactivation of various microorganisms by ozone. A comprehensive review of potable water disinfection was published which summarized aspects of wastewater chlorination. One paper reported on the use of chlorine for the prevention of well clogging during groundwater recharge, while another dealt with the inactivation by ozone of six viruses in a continuous flow reactor. The effects of disinfectants on higher organisms were investigated in studies of bluegill, catfish, bass, crustaceans, and insects. One epidemiologic study found a significant positive correlation between pancreatic cancer and trihalomethane levels in drinking water. New analytical methods were described, and the chlorination of inorganic compounds was explored by several studies. The formation of trihalomethanes was also investigated, including one study on the influence of ozone pretreatment on their formation. (Small-FRC)
W82-01250

WASTEWATER COLLECTION,
AES Engineers, Inc., Willow Springs, IL.
S. Chatterjee, and T. Heuer.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 748-750, June, 1981. 32 Ref.

Descriptors: *Sewer systems, *Literature review, *Bibliographies, Wastewater facilities, Design criteria, Construction, Rehabilitation, *Wastewater collection.

A review of the 1980 literature published on wastewater collection is presented. It covers publications in the areas of design and construction, sewer rehabilitation, safety, and wastewater pumping. Papers referenced include a concise and systematic method for the determination of optimum sewer diameter and slope for a given flow capacity. Another paper noted water conservation measures that may reduce wastewater flows by 25%. One experimental study demonstrated the use of conduits for wastewater treatment using sludge and air/oxygen supply. Sewer rehabilitation topics included a study emphasizing the need for assessment of infiltration/inflow problems in order to better define the role of sewage treatment plant operators. An overview was presented of the potential methods of combined sewer overflow pollution abatement. Safety was addressed in several papers, one of which attributed most sewer worker deaths to hydrogen sulfide gas rather than lack of oxygen. Troubleshooting techniques for wastewater pumping systems were outlined in one paper, and the results of an EPA pipe needs survey were published. (Small-FRC)
W82-01251

LAND APPLICATION OF MUNICIPAL WASTEWATER,
Nielson, Maxwell and Wangsgard, Salt Lake City, UT.
J. H. Reynolds.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 767-770, June, 1981. 30 Ref.

Descriptors: *Land disposal, *Literature review, *Municipal wastewater, *Bibliographies, Water reuse, Overland flow, Denitrification, Infiltration, Design criteria.

A literature review is presented on the land application of municipal wastewater. Articles published during 1980 covered the general topics of design parameters, case studies, and water reuse. General publications included a history of the federal water pollution control legislation, including a discussion of EPA policy on land treatment. A published review of the recent application of overland flow treatment of municipal wastewater included a design guide based on operating experience in Davis, California. Laboratory studies on design parameters included a study of nitrogen removal and infiltration rates using primary effluent applied to soil columns. The long-term effects of irrigation with wastewater as well as the effects of rapid infiltration were examined. Reuse studies included groundwater recharge with tertiary effluent by way of spreading basins, and a water quality management facility which is designed to demonstrate

innovative techniques for recycling municipal wastewater including a lake-land treatment system. (Small-FRC)
W82-01253

HEALTH EFFECTS ASSOCIATED WITH WASTEWATER TREATMENT AND DISPOSAL,
Environmental Protection Agency, Cincinnati, OH.
For primary bibliographic entry see Field 5C.
W82-01255

MEAT-, FISH-, AND POULTRY-PROCESSING WASTES,
Battelle-Columbus Lab., Columbus, OH.
J. H. Litchfield.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 787-791, June, 1981. 1 Tab, 56 Ref.

Descriptors: *Meat processing industry, *Fish handling facilities, *Poultry, Industrial wastewater, *Food processing industry, Proteins, Land disposal, Wastewater disposal, *Wastewater treatment, Lagoons, Flotation, Odor control, Reviews.

Meat processing wastewaters were successfully treated in aerated lagoons, by electrocoagulation and flotation of fat and oil, in a vertical cylindrical separating chamber, in an electrolytic microbubble system using a noncoagulant mineral acid, and by digestion (fellmongering wastes). In addition to publications on environmental regulations and bibliographies, work was done on fish processing wastewater treatment by primary methods, pressure flotation, activated sludge, rotating disks, activated carbon-activated sludge, coagulation, aerated chambers, and recovery of protein for reuse. Water from poultry processing was frequently land-applied. Other treatment systems were chemical coagulation, DAF treatment, aerated lagoons, clarification, stabilizing lagoons, filtration, ultrafiltration, and breakpoint chlorination. Disinfection of poultry wastewater was accomplished with chlorine or chlorine dioxide. Odors from an anaerobic lagoon system were controlled by treating the odorous air with gaseous chlorine, dilute acid bed, and dilute caustic bed, in series. (Cassar-FRC)
W82-01256

FERMENTATION INDUSTRY,
Notre Dame Univ., IN.
R. L. Irvine.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 791-795, June, 1981. 57 Ref.

Descriptors: *Fermentation, Wastewater disposal, *Wastewater treatment, Reviews, Aerobic treatment, Anaerobic digestion, Biological treatment, *Industrial wastewater.

The 1980 literature on treatment and disposal of fermentation industry wastes includes 18 review articles on general subjects; reuse, recycle, and recovery of single-cell protein and other products; and comparisons of treatment alternatives (anaerobic systems were generally superior to aerobic treatment). Some of the individual papers describe treatment alternatives. A Canadian brewery uses a full-scale deep shaft treatment facility to meet pretreatment effluent standards of 300 g per cu meter BOD and 350 g per cu meter suspended solids. Bench scale continuous flow activated sludge reactors removed > 90% of brewery wastewater COD in another study. Problems with filamentous organisms in bench reactors were solved by aerating recycled sludge separately for 19-32 hours before return to the aeration basin. Distillery waste treatment methods included ultrafiltration, reverse osmosis, electrodialysis, and anaerobic treatment. Winery wastewaters were easily and inexpensively disposed of on soil with good drainage. Formaldehyde in pharmaceutical fermentation waste products was reduced to 0.5-1 g per cu meter using a maximum initial concentration of 1200 g per cu meter and 3 weeks incubation. Other treatment methods for pharmaceutical wastes included aerobic digestion, biological treatment, and biofiltration. (Cassar-FRC)
W82-01257

DAIRY WASTES,
Kraft, Inc., Glenview, IL.
J. C. Groenewold.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 795-797, June, 1981. 34 Ref.

Descriptors: *Dairy industry, *Wastewater treatment, Industrial wastewater, Milk, Activated carbon, Trickling filters, Flotation, Reviews.

Recent literature on managing dairy industry wastewaters included papers on minimizing the amount of waste by improving manufacturing processes and equipment, characterization of wastewaters from a multiproduct plant, and whey disposal and utilization. In individual papers the following subjects were discussed: discharge of dairy plant wastewater without pretreatment into a properly functioning municipal treatment system, advantages of deep shaft treatment facilities, use of trickling filters to remove 50% BOD as a pretreatment, land disposal on soil with good drainage properties, activated carbon treatment of a 164.5 g per cu meter carbohydrate and 23.5 g per cu meter protein wastewater, extended aeration activated sludge treatment (removed 99% BOD and 95-98% suspended solids), the difference in the metabolic rates for lactose and proteins in a milk plant wastewater, activated sludge-biological filters, and an aerated lagoon treatment system for ice cream waste. Current research concerned protein removal with activated carbon (96% BOD, 93% solids, 91% hexane extractables), acidification and continuous air flotation for protein and fat removal, electroflotation, electrocoagulation with ferric chloride addition, and the best grases for a cold weather cheese factory irrigation system. (Cassar-FRC)
W82-01258

TEXTILE WASTES,
Auburn Univ., AL.
J. F. Judkins, Jr.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 797-799, June, 1981. 25 Ref.

Descriptors: *Textile mill wastes, *Dye industry wastes, Reviews, *Wastewater treatment, Industrial wastewater, Flotation, Flocculation, Surfactants, Ozonation, Chlorination, Oxidation, Activated carbon, Adsorption, Water reuse, Aerobic treatment.

The variety of substances (dyes, retarding agents, softening agents, surfactants, fibers, sizing agents, etc.) occurring in textile wastewaters requires a variety of treatment processes. Some of the recent developments in textile wastewater treatment are reviewed: equalization and neutralization, flocculation, flotation, activated sludge treatment, evaporation, activated carbon adsorption, ozonation, chemical coagulation, biological treatment, chlorination, reverse osmosis, foam fractionation, gamma radiation, wet oxidation, ion exchange, TSF filtration process, ultrafiltration for size recovery, and aerobic digestion. The reuse of partially purified water or recycled municipal effluent for some processes such as rinse water or dyeing water was studied. (Cassar-FRC)
W82-01259

PULP AND PAPER INDUSTRY EFFLUENT MANAGEMENT,
National Council for Air and Stream Improvement, Inc., Medford, MA.
G. W. Gove.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 799-814, June, 1981. 158 Ref.

Descriptors: *Pulp and paper industry, *Water pollution effects, Secondary wastewater treatment, Industrial wastewater, Wastewater treatment, Regulations, Economic aspects, Forest management, Effluents, Model studies, *Reviews, Aquatic life, Pollutant identification, Water pollution prevention, Color removal, Coagulation, Clarification, Foam separation, Sludge disposal.

This review of recent papers on pulp and and paper industry wastewater is divided into five classifications. General subjects include national policies, economics, and sources and treatment of effluents. Studies on receiving waters, biological effects of pulp and paper mill effluents, and characterization of effluents resulted in information on predicting the path of pollutants in rivers, containment of wastewaters in ponds, bioassays of aquatic life (fish, shellfish, phytoplankton), mutagenicity of components in mill effluents, a fish tainting protocol, guidelines for priority pollutant sampling and analysis, analytical methods for effluents, and characterization of process streams. Pulping liquor disposal and recovery work concerned methods to reduce the amount of pollutants discharged into the environment. Physicochemical treatment methods include changes in various processes to minimize pollutant formation; water recycling and reuse; coagulation; clarification; ultrafiltration, radiation, and biological treatment for color reduction; condensate stripping; fractionation; membrane techniques; ion exchange; electrochemical processes; and ozonation. Secondary treatment processes in use on the plant scale are: activated sludge, oxygen activated sludge, aerated stabilization basins, 2-stage biological treatment, and flood irrigation of tree plantations. Laboratory and pilot plant secondary treatment studies concern filamentous growth in oxygen activated sludge plants, biological filters, short circuiting in oxidation ponds, and the oxygen balance in aeration tanks. (Cassar-FRC)
W82-01260

PETROLEUM PROCESSING WASTES,
Oklahoma State Univ., Stillwater.
E. L. Stover, and M. F. Torpy.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 824-828, June, 1981. 53 Ref.

Descriptors: *Oil recovery, *Water reuse, *Wastewater treatment, Industrial wastewater, Reviews, Oil wastes, Organic compounds, Flotation, Filtration, Ultrafiltration, Algae.

A review of recent literature on petroleum processing wastes includes information on regulations, literature reviews, analytical methods, and treatment systems. An analytical method for polynuclear aromatic hydrocarbons at levels of 1.0 micrograms per liter has been used successfully. One widely used treatment process for wastes of simple to complex composition included API primary treatment, granular filtration, and biological filtration. Dissolved air flotation and electrolyte techniques were more effective in oil and grease removal than was dispersed air application. Tubular ultrafiltration systems produced effluents meeting regulatory requirements; 2 to 3 year membrane lives were expected. Several aerobic treatment units operating at refineries produced effluents with total BOD of 13 mg per liter. In one case, oily wastewater and domestic wastewater were treated in 2-stage aeration tanks. Mutant microbes adapted to refinery wastes were studied in the laboratory and with mathematical models. The activated sludge process was improved by using high sludge age and adding powdered activated carbon. Other methods of treating refinery wastewaters included single cell algae (Chlorella and Scenedesmus), land application to crops, reverse osmosis and reuse in the refinery, lime soda ash, and evaporation using waste heat as an energy source. A method for recovering fuel oil from contaminated groundwater was described. Laboratory studies on transport of oil to the sediments in an estuarine system showed that 10-20% persisted after a year. (Cassar-FRC)
W82-01262

SYNTHETIC FUEL EFFLUENTS,
Argonne National Lab., IL.
For primary bibliographic entry see Field 5B.
W82-01263

STEEL INDUSTRY WASTES,
Environmental Protection Service, Burlington (Ontario). Waste Water Technology Centre.
D. T. Vachon, and N. W. Schmidtke.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 844-847, June, 1981. 58 Ref.

Descriptors: *Metal finishing wastes, *Steel industry, *Wastewater treatment, Industrial wastewater, Reviews, Heavy metals, Cyanide.

The past year's literature on steel industry wastes included general articles on environmental impacts, including water quality, and pollution control regulations. Water recycling systems were the subject of 7 papers. Wastewater from coke production was treated by several processes: hydrogen peroxide; separate removal of ammonia, cyanide, and oil, with recombination for phenol and organics removal by biological oxidation; FeSO4 plus polyacrylamide; precipitation of iron cyanides with Na salts of sulfite, thiosulfate, dithionite, and pyrosulfite; ion exchange; nitrification; and settling tanks with filter beds. Dry quenching was less damaging to the environment than wet quenching. Blast furnace gas scrubbing water was treated with alkaline chlorination, ozonation, and reverse osmosis. Magnetic filtration was effective in removing suspended solids from hot strip mill effluent. Pickling wastewater lowered phosphorus levels and improved process operating conditions in municipal wastewater treatment systems. Metal finishing wastewaters, high in heavy metal and cyanide, were subjected to electrolytic precipitation, evaporation, reverse osmosis, ion exchange, electrodialysis, ozonation, and many other methods. (Cassar-FRC)
W82-01264

ELECTROPLATING AND CYANIDE WASTES,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
W. R. Knocke.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 847-851, June, 1981. 47 Ref.

Descriptors: *Metal-finishing wastes, *Cyanide, *Heavy metals, Wastewater treatment, Industrial wastes, Reviews, Metals, Chromium, Cadmium, Regulations, Water conservation, Ozonation, *Electroplating.

A review of 1980 literature on electroplating and cyanide wastes included recent regulations and methods for wastewater treatment and analysis. Four categories of metal finishing wastes were classified as hazardous under the Response Conservation and Recovery Act, Part 261.31: spent solutions from electroplating operations, wastewater treatment sludges from electroplating operations, plating sludges from plating baths, and spent stripping and cleaning solutions from plating operations. It was expected that 1680 of the 2336 operating electroplating jobshops would be closed because of the new regulations. Processes for wastewater treatment and metals removals were: sulfide precipitation techniques, electrolytic ferrite formation for removal of chromate, seawater electrolysis, chromium ferrocyanide gels, chelating resins containing an iminodipropionic acid salt, and the surfactant Amifat (N-acyl-L-glutamic acid). A centralized system was proposed to treat wastes from 10 nearby shops in Providence, Rhode Island. Metal recovery techniques which conserve energy, metals, and water were reviewed. These involved temperature modifications, evaporative recovery, filtration, ion exchange, electrolytic transfer systems with polyester membranes, and electrochemical cells. Cyanide waste treatment was examined by several authors. Some of the processes were: ozonation, activated carbon adsorption, heating to 210 C in a sealed container, percolating through a column of steel scrap, and algal systems which work best at cyanide levels < 1 mg per liter. Sludge treatment and disposal methods were reviewed. (Cassar-FRC)
W82-01266

CHEMICALS AND ALLIED PRODUCTS,
Union Carbide Corp., South Charleston, WV.
T. W. Siegrist.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 851-861, June, 1981. 139 Ref.

Descriptors: *Chemical wastewater, *Organic compounds, *Activated carbon, *Wastewater treatment, Reviews, Industrial wastewater, Regulations, Physicochemical treatment, Insecticides, Phenols, Ozonation, Biological treatment, Oxidation, Water reuse.

Waste treatment in the chemical industry was reviewed. Costs of pollution abatement were outlined in several papers. Treatment methods, classified by product type, were discussed for phenol and derivatives (adsorption with activated carbon and/or polymers, acidification with sulfuric acid plus alpha-ray irradiation, ozonation, combined physicochemical and biological treatment); polychlorinated biphenyls (ultraviolet-ozone treatment, critical-fluid extraction, bacterial degradation); kepone (aerobic treatment, photolytic decomposition promoted by amines); dioxins (bacterial oxidation); fatty acid wastes (upflow anaerobic treatment); and other organic compounds--heterocyclics, halogenated diphenylmethanes, melamine-formaldehyde resin wastewater, methanol manufacturing wastes, glycol and glycerol production wastes, butyl benzyl phthalate, dichloromethane, and 3,3'-dichlorobenzidine. Wastes treated at the source for recycling, recovery, or pretreatment purposes included those from manufacturing of fertilizers, acrylic monomers, organic solvents, benzene, munitions, polystyrene, caprolactam, and polyester fibers. A variety of organic chemicals were degraded by biological treatment. Physical-chemical treatment for chemical pollutants was the subject of 42 papers, for example, trihalomethanes, trichloroethylene, petrochemical wastewaters, phenol and derivatives, polychlorinated biphenyls, proteins, amino acids, polysaccharides, phthalates, oil and grease, and heavy metals. Activated carbon treatment was widely used for many of these wastes. Other treatment processes were wet oxidation, shipboard incineration, ozonation-radiation, reverse osmosis, steam stripping, electrolytic treatment, ion-precipitate flotation, and solidification. (Cassar-FRC)
W82-01267

RADIOACTIVE WASTES,
Oak Ridge National Lab., TN.
B. G. Blaylock, and C. S. Fore.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 861-896, June, 1981. 8 Tab, 375 Ref.

Descriptors: *Radioactive wastes, *Path of pollutants, Waste disposal, Regulations, Radioisotopes, Uranium, Water pollution control, Industrial wastes, Literature review.

Several topics pertinent to water pollution were included in a review of the 1980 literature on radioactive wastes. Eight tables summarize the activities at symposia and workshops. The remaining literature has been divided into nine categories: general programs, isolation, waste treatment, storage, environmental transport, monitoring, risk assessment, remedial action programs, and socioeconomic aspects. The path of radioactive materials buried in rocks was studied by several authors. One stated that leach rate experiments were grossly over-pessimistic. Data was collected as input for a model which will predict the fate of radionuclides in canisters dumped into the ocean. Shallow land burial for low-level wastes was studied, and the danger of water penetration and plant root penetration noted. About 85 papers concerning radioactive waste treatment were classified as follows: volume reduction, incineration, calcination, vitrification, solidification, partitioning (separating) and transmutation (changing) troublesome radionuclides, transuranic wastes, and facilities for handling wastes. Migration of radionuclides in the environment (theoretical and case studies) was described by many authors. Over 350 computer models have been developed for this purpose. Remedial action programs included regulations and methods for prevention and cleaning up of uranium mill tailings at several active and inactive sites. (Cassar-FRC)
W82-01268

MICROBIOLOGY OF WASTEWATER TREATMENT,
Drexel Univ., Philadelphia, PA.
W. O. Pipes.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1142-1145, June, 1981. 44 Ref.

Descriptors: *Microbiological studies, *Viruses, *Water pollution sources, Reviews, Activated sludge, Microorganisms, Pathogens, *Wastewater treatment, Industrial wastewater, Sphaerotilus, Trickling filters, Oxidation ponds, Land disposal, Indicators, Bacteria.

A variety of subjects is included in a review of recent literature on wastewater treatment microbiology. Bacteria causing a filamentous sludge were identified as Sphaerotilus and Leucothrix. Some of the conditions inhibiting growth of these undesirable organisms were dissolved oxygen concentrations above 2 mg per liter, chlorination of return sludge, presence of antibiotics, and soluble Fe. Other studies on activated sludge concerned a method for estimating the viable fraction of microorganisms, a prey-predator model, and a method for enumeration of bacteriophages. Oocystis cells were used in a two-phase tertiary treatment process in ponds. Ozone doses of 15-50 mg per liter removed 98% of green algae from an oxidation pond. Virus survival in land application of wastewater was studied by several authors. Since drying inactivated the viruses, a cyclic application procedure was suggested. Clays removed viruses most effectively, and sandy soils the least. The first 5 cm of soil adsorbed about 75% of the viruses. Later, mobilization by rain caused viruses to be readsorbed at lower levels in the soil profile. In the sludge treatment process viruses were quickly inactivated in an anaerobic digester. However, fecal coliforms were destroyed 7-8 times faster at mesophilic temperatures and 9-10 times faster at thermophilic temperatures. Microorganisms suitable for degrading certain industrial wastewaters were found for distillery wastes and lemonade processing water. In searches for bacterial indicators of viruses, there was no relationship between coliforms and certain viruses. Several authors measured airborne pathogens near wastewater treatment plants. (Cassar-FRC)
W82-01291

FORMATION OF N-NITROSODIMETHYLAMINE DURING TREATMENT OF MUNICIPAL WASTE WATER BY SIMULATED LAND APPLICATION,
Cornell Univ., Ithaca, NY. Dept. of Agronomy.
S. Greene, M. Alexander, and D. Leggett.
Journal of Environmental Quality, Vol 10, No 3, p 416-421, July-September, 1981. 4 Fig, 1 Tab, 28 Ref.

Descriptors: *Nitrogen compounds, *Land disposal, *Wastewater treatment, Municipal wastewater, Nitrogen, Simulation analysis, Nitrosation, Carcinogens, Mathematical equations, Nitrites, Soil filters, Soil water, Notrosamines, *Leachates.

N-nitrosamines represent a group of potentially serious pollutants which may be formed or leached through soil when wastewater is applied to land. One of these, N-nitrosodimethylamine (NDMA) is a highly toxic compound which can be formed from amines added by pesticides or root excretions in nitrate-amended soil. The extent of NDMA formation and the behavior of its precursors were examined in soils incubated with sewage and in effluent from soil columns percolated with sewage. NDMA formation was investigated in Lake George sand and Arkport fine sandy loam amended with sewage, 250 micrograms of dimentylamine (DMA), and 50 micrograms of nitrite-nitrogen per gram. Although the rates of NDMA formation were similar in the two soils, the rates of destruction of DMA and nitrite differed significantly between the two soils. Both DMA and nitrite levels

decreased more rapidly in the Arkport soil than in the Lake George soil. The amount of NDMA that accumulated in Lake George sand amended with sewage under nonpercolating conditions was found to be a linear function of the amount of DMA and nitrite added. On a molar basis, 0.8% of the DMA and 1.3% of the nitrite added to the soil was converted to the carcinogen, NDMA. Smaller amounts of conversion occurred when sewage containing the precursors was percolated through this soil. The moisture level of the soil also influenced the extent of nitrostation. These findings demonstrate the facility with which NDMA leaches through soils. Although it is not known whether DMA and nitrite levels ever reach concentrations high enough to result in NDMA formation in the field, the demonstrated fact that nitrosamine formation is likely to occur under conditions resembling those of land application of wastes suggests that groundwater and surface water near existing land treatment areas should be monitored for NDMA and other nitrosamines. (Carroll-FRC)
W82-01343

REMOVAL OF PHOSPHORUS FROM WASTE WATER BY SOIL UNDER AEROBIC AND ANAEROBIC CONDITIONS,
Connecticut Agricultural Experiment Station, New Haven.
D. E. Hill, and B. L. Sawhney.
Journal of Environmental Quality, Vol 10, No 3, p 401-405, July-September, 1981. 6 Fig, 2 Tab, 25 Ref.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Soil filters, Anaerobic conditions, Aerobic conditions, Groundwater pollution, Fertilizers, Tile drains, Soil absorption capacity.

Previous studies have demonstrated that the movement of phosphorus added to soils in wastewater or as fertilizer is extremely slow. Reducing conditions caused by flooding in cultivated soils with tile drains can increase the mobility of this phosphorus, however. A simulated wastewater containing 12 micrograms of phosphorus per milliliter of solution was added to a fine sandy loam soil underlain by bedrock at 72 centimeters two or three times a week over a 2.5 year period. The water table fluctuated between 25 and 75 centimeter depths during this period. Analyses of the effluent from weep holes at different depths indicated that the wastewater moved along preferred pathways in heterogeneous soil and produced breakthrough of phosphorus to ground water before all sorption sites were fully saturated with phosphorus. The mobility of phosphorus increased under the anaerobic conditions produced when the water table was closest to the surface. This enhanced mobility increases the transport of phosphorus to the groundwater in soils which are used for continued wastewater disposal. The phosphorus sorption capacity of a soil is reduced by long-term wastewater renovation, although sorption sites can be regenerated and the potential for additional phosphorus sorption increased by periodic resting. There was a reasonably good agreement between estimates of phosphorus retention based on its concentration in influent and effluent solutions and bulk density of the soil and laboratory determinations of phosphorus retained following wastewater renovation. Most of the phosphorus retained in the soil is transformed into unavailable forms. (Carroll-FRC)
W82-01344

SANITATION SERVICE MANAGEMENT IN FRANCE (LA GESTION DES SERVICES D'ASSAINISSEMENT EN FRANCE),
Ingenieurs a la Societe Lyonnaise des Eaux et de l'Eclairage, Paris (France).
For primary bibliographic entry see Field 6F.
W82-01351

A LOOK AT SOME WATER RECLAMATION PLANTS IN SOUTHERN AFRICA,
National Institute for Water Research, Pretoria (South Africa).
J. Van Leeuwen, L. R. J. Van Vuuren, J. W. Funke, and A. J. Clayton.
Aqua, No 2, p 0256-0262, 1981. 6 Fig, 1 Tab, 25 Ref.

Descriptors: *Water reuse, *Water resources development, *Wastewater renovation, Water use, Water quality, Water pollution control, Drinking water, Potable water, *Water conservation, *South Africa.

Various water reclamation plants operation in South Africa are reviewed, including the Sappi plant near Springs, the Mondi plant near Durban, the Stander Water Reclamation Plant at Pretoria, the LFB pilot plant at Pretoria, the Athlone pilot water reclamation plant at Cape Town, and the Windhoek Water Reclamation Plant in South West Africa. A review of these plants indicated that it is possible to reclaim water from wastewater for many applications. Water can be reclaimed to conform to any quality criteria, including those for potable water. Reclaimed water may in many cases be an economically viable alternative to water from conventional, potable supplies. Cooperation between local authorities and industry is a vital part of the success of any reclamation operation. In southern Africa the cost of reclaimed water is about equal to the consumer price of drinking water obtained by conventional purification of surface water. In some cases costs of pumping water from distant sources are high, and it may prove economical to distribute reclaimed water from wastewater sources which are easily accessible. Since quality standards for industrial processes are lower than for domestic reuse purposes, the cost is lower for industrial reuse. The relatively low irrigation water quality requirements in the area lend themselves to water reuse without costly intermediate treatment. Water reclamation not only offers an extension of the usefulness of a given quantity of water, but can also play an important role in combating pollution. (Baker-FRC)
W82-01352

EXPANSION OF EFFLUENT CONSTRAINED TREATMENT PLANTS,
Newcastle Univ., New South Wales (Australia). Dept. of Civil Engineering.
B. J. Williams.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No EE3, p 571-589, June, 1980. 7 Fig, 9 Tab, 10 Ref.

Descriptors: *Water treatment facilities, *Cost analysis, Design criteria, Water quality, Wastewater treatment, Land application, Wastewater facilities, Loading rate.

An approach is presented for use in planning an extension of sewage treatment plants to provide both for increased loads of sewage and for more stringent controls on the concentrations of various pollutants in the effluents from the treatment plants. The objective is to determine what size primary, secondary, and tertiary treatment plants should be built in each of several planning stages in order to minimize total discounted costs over the entire planning period and provide sufficient treatment for the increasing raw sewage load. The plan was applied to the Melbourne and Metropolitan Board of Works Farm (MMB), which has represented a very successful example of land treatment of sewage for the last 85 years. The farm comprises a carefully operated system of land filtration, grass filtration and lagoons, but has become overloaded over the past few years. Extension is limited by the availability of suitable land. The MMB plans to build conventional treatment plants on the site to supplement the farm. The proposed schemes involve continued use of existing farm treatment processes plus primary and secondary treatment with either tertiary treatment or an outfall to Bass Strait. A series of sensitivity tests has been carried out on operations and maintenance costs of plant and the farm, predicted sewage loads and scale factors. The most important of these was the effect of variation in sewage load. A 10% reduction in waste load results in savings of between 17 and 24% for the 1 and 8% discount rates. Relaxation of the water quality constraint allows substantial savings to be made in treatment costs. (Baker-FRC)
W82-01355

DESIGN AND CONSTRUCTION OF SHIELDHALL SEWAGE-TREATMENT WORKS, GLASGOW,
Strathclyde Regional Council (Scotland).
W. T. Greer.
Water Pollution Control, Vol 80, No 2, p 260-272, 1981. 10 Fig.

Descriptors: *Wastewater treatment, *Design criteria, Water treatment facilities, Economic aspects, Construction, Planning, Costs, *Glasgow drainage area, Great Britain.

Shieldhall was the third and last sewage treatment works built to serve the Glasgow drainage area. It was opened in May of 1910. Site selection had been beset with difficulties over the years. Until the early 1960's siting choice was restricted by the fact that the most valuable industrial land in Glasgow was along the riverside and adjacent to the shipyards. After siting problems had been solved, a new wastewater treatment works was designed for the area, which would produce a 30:20 standard effluent. In view of the necessity of maintaining treatment throughout the reconstruction period, it was decided to build the new works in two phases. Phase I was constructed on newly acquired ground and consists of a low-level pumphouse, presedimentation works, primary-sedimentation tanks, storm-sewage tanks, a sludge pumphouse and underground storage tanks, sewer diversions and a new outfall channel to the River Clyde. Phase II was to include aeration tanks, secondary settlement tanks, a return activated-sludge pumphouse and a further overhead sludge-storage tank. Work began on Phase I in April of 1975. Permission has now been obtained to proceed with phase II, and the civil engineering work commenced in March of 1980. The entire project is to be completed by 1984. (Baker-FRC)
W82-01385

SCAYNES HILL STW EXTENSIONS INCLUDE PLASTIC MEDIA FILTRATION.
Water Services, Vol 85, No 1020, p 92-93, 95, February, 1981. 3 Fig.

Descriptors: *Wastewater treatment, Sludge lagoons, Lagoons, Wastewater irrigation, Filtration, Tertiary wastewater treatment, *Water treatment facilities, Haywards Heath sewage, Great Britain.

Prior to 1905 Haywards Heath sewage was treated at three separate sewage farms. In 1934, due to pollution of the River Ouse, a modern disposal works was begun to replace the broad irrigation system that had been in use. This new system consisted of four brick inverted pyramid primary settling tanks with a total capacity of 814 cubic meters and six brick percolating filters containing 2800 cubic meters of clinker. Phase I of a new sewage system began in 1961 to deal with flooding at Ashenground. Phase II consisted of enlarging the Scaynes Hill Works and laying a 840 mm gravity sewer. Phase III involved the closure of another works and construction of a pumping station. Each of these phases was completed by 1966. In 1971 the sludge lagoons were abandoned and a vacuum filtration sludge dewatering plant constructed with three tertiary effluent lagoons. Recently two settling tanks with mechanical scrapers were built to supplement the two existing ones, and the four tanks now handle all incoming flows up to 21,600 cubic meters/day. (Baker-FRC)
W82-01386

RURAL SANITATION IN DEVELOPING COUNTRIES,
Hawksley (Watson), High Wycombe (England).
J. M. Sidwick.
Effluent and Water Treatment Journal, Vol 21, No 5, p 210-212, 214, 215, May, 1981. 2 Fig, 3 Tab, 10 Ref.

Descriptors: *Waste disposal, *Developing countries, *Sanitation, Public health, Rural areas, *Wastewater treatment, Methane, Septic tanks, Agriculture, Composting, Fish ponds, Algae, Irrigation, Wastewater irrigation, Land disposal.

Disposal methods for human excreta in developing countries are evaluated and compared. In the ab-

sence of adequate waste disposal, the benefits from water supplies being developed through the International Drinking Water Supply and Sanitation Decade programs are reduced. Low cost methods listed in order of increasing mean total cost ($18.7-$64.9 per household per year in 1978 dollars) are pour flush toilet, pit privy, communal toilet, vacuum truck cartage, low cost septic tank, composting toilet, and bucket cartage. Although many of these disposal methods produce odors, insect problems, and health hazards in handling and removal, they can provide an answer to handling excreta in rural areas until more effective waterborne sewage systems are feasible. Reuse of excreta is a widely used disposal method throughout the world. However, public health hazards must be reduced to an absolute minimum. The main reuse options are direct use of nightsoil on the land, composting, wastewater irrigation, agriculture, algae and fish culture, animal food, and biogas production. (Cassar-FRC)
W82-01392

NEW APPROACHES TO ANAEROBIC SLUDGE DIGESTION,
Water Pollution Research Lab., Stevenage (England).
A. M. Bruce.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 3, p 215-229, May 1981. 4 Fig, 5 Tab, 35 Ref.

Descriptors: *Anaerobic digestion, *Sludge digestion, *Wastewater treatment, Biological treatment, Biodegradation, Digestion, Composting, Aerobic digestion, Lime, Sludge thickening, Lagoons, Great Britain.

Mesophilic anaerobic sludge digestion has been a satisfactory process since its development in the 1920's. The high initial cost is a disadvantage. Of the alternative processes reviewed (aerobic digestion, lime stabilization, and composting) lime stabilization is most satisfactory, depending on the local cost of lime and the land available for disposal. The efficiency of the conventional single stage, completely mixed reactor design may be improved either by reducing retention periods or by thickening sludge before digestion. Recent experiments have shown that mesophilic digestion of raw sludge of up to 9% solids and retention periods as low as 13 days may be satisfactory. Removing dead zones by adequate mixing and grit removal also improves efficiency. A graph shows the effect of population size on capital costs of a primary anaerobic digestion plant at different loading rates (1 to 4 kg volatile solids per cu meters per day). (Cassar-FRC)
W82-01398

REMEDIAL TECHNIQUE OF CONTROLLING AND TREATING LOW VOLUME LEACHATE DISCHARGE,
Nassaux-Hemsley, Inc., Chambersburg, PA.
For primary bibliographic entry see Field 5G.
W82-01428

COMPARATIVE EVALUATION OF PROCESSES FOR THE TREATMENT OF CONCENTRATED WASTEWATERS AT UNCONTROLLED HAZARDOUS WASTE SITES,
TRW Environment Engineering Div., Redondo Beach, CA.
M. Ghassemi, K. Yu, S. Quinlivan, and F. J. Freestone.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 160-164, 4 Tab.

Descriptors: *Wastewater treatment, *Wastewater facilities, *Hazardous materials, *Evaluation, Economic aspects, Reverse osmosis, Ultrafiltration, Ion exchange, Wet oxidation process, Coagulation, Precipitation, Activated sludge process, Ozonation, Waste disposal sites.

This paper summarizes the results of an evaluation of the suitability and economics of several commercially available water and wastewater treatment processes for use in mobile units for on-site treatment of highly contaminated waters. Seven processes were evaluated: reverse osmosis (RO); ultrafiltration (UF); ion exchange (IE); wet air oxidation (WAO); high purity oxygen activated sludge process (HP); UV-ozone oxidation (UV); and coagulation/precipitation (CP). It was assumed the equipment mounted on a single trailer would treat 227,000 l/day, based on single processes, not combinations. All the processes except UF and UV are widely used commercially and all but HP, CP, RO and IE appear to be the most promising processes, because they are compact, quick to start and stop, convenient to service, and do not require skilled field operating labor. The necessary electricity can be generated on-board and they can handle a wide variety of wastes. None of the processes was effective individually, but RO and IE could be made so with either pretreatment of post-treatment, or a combination of two processes could be used. Capital costs range from $35,000-$650,000; labor, energy, and materials costs also vary widely. (Brambley-SRC)
W82-01430

EVALUATION OF REMEDIAL TREATMENT, DETOXIFICATION AND STABILIZATION ALTERNATIVES,
Anderson-Nichols and Co., Inc., Boston, MA
M. A. Sills, J. J. Struzziery, and P. T. Silbermann.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 192-201, 5 Fig, 3 Tab, 9 Ref.

Descriptors: *Groundwater pollution, *Groundwater management, *Water pollution control, *Waste disposal, *Hazardous material, Detoxification, Immobilization, Stabilization, Wastewater treatment, Wastewater collection, Wastewater disposal, Economic aspects, Environmental effects.

A systematic evaluation procedure has been developed for the identification of the most cost effective, environmentally sound treatment, detoxification or stabilization methods for the remedial management of uncontrolled hazardous waste sites. In situ detoxification, stabilization and immobilization techniques have been developed. Detoxification involves the injection of chemicals or biological agents into the contaminated soil. Stabilization is accomplished by converting contaminants to insoluble forms through chemical reactions, or encapsulating them in a highly insoluble matrix. Immobilization techniques may be applied alone or in conjunction with others; they rely on the injection of materials which prevent further movement of the contaminants. Withdrawal, treatment and disposal options depend on the nature of the site and the contaminants. Collection and withdrawal methods include collection wells, subsurface gravity collection drains, impervious grout curtains, and cut-off trenches, while the treatment options include reverse osmosis, ultrafiltration, ion exchange, wet air oxidation, activated carbon, ozonation/UV radiation, and chemical and biological treatment. Three final disposal options to be evaluated are discharge to municipal sewage treatment plant, discharge to a surface water body, and land application. The systematic two-phase iterative screening procedure identifies the most promising management alternatives in the first phase, then subjects them to more intense technical, economical and environmental evaluations. (Brambley-SRC)
W82-01434

BACKGROUND DOCUMENT FOR MODIFICATION OF PH EFFLUENT LIMITATIONS GUIDELINES AND STANDARDS FOR POINT SOURCES REQUIRED BY NPDES PERMIT TO MONITOR CONTINUOUSLY EFFLUENT PH.
Environmental Protection Agency, Washington, DC. Office of Analysis and Evaluation.
Report EPA-440/2-80-083, November, 1980. 132 p, 6 Fig, 21 Tab, 13 Ref.

Descriptors: *Industrial wastewater, *Hydrogen ion concentration, *Monitoring, *Regulations, Water pollution control, Water quality standards, Effluents, Industrial plants.

The information presented in this report evolved in response to a petition from various industries seeking relief from absolute compliance with the 6-9 pH categorical standard when continuous monitoring is required. The standard of pH 6-9 was initially intended for those situations where grab or composite samples were to be monitored, but has been adopted for use in continuous monitoring situations. Two studies were conducted to verify the original regulations. A total of 15 plants were visited, each of which was using continuous pH monitoring, and their monitoring data were surveyed to determine how frequently the effluent was out of the standard pH range. The causes of the excursions out of range were identified. Thirteen of fourteen plants for which data were available were able to achieve compliance over 99% of the time over periods of 6 months and more. On a monthly basis eight of the plants had at least one month exceeding a 99% monthly standard. The long excursions from the standard were usually due to process or treatment system upsets, and instrumentation malfunctions, none of which should be a factor in modifying pH standards. The EPA maintains the 99% monthly compliance time, and recommends that a plant is not to be outside the categorical pH range continuously for more than 30 min. (Brambley-SRC)
W82-01438

ENVIRONMENTAL IMPACT AND HEALTH EFFECTS OF WASTEWATER CHLORINATION,
Illinois Univ. at the Medical Center, Chicago, IL. School of Public Health.
G. R. Brenniman.
Illinois Institute of Natural Resources, Chicago. Document No 81/27, July 1981. 63 p, 8 Tab, 149 Ref.

Descriptors: *Chlorination, *Wastewater treatment, *Residual chlorine, *Public health, Chloriform, Water treatment, Chlorinated hydrocarbons, Carcinogens, Fish toxins, Safety, Toxicity, Epidemiology, *Environmental effects.

There are some benefits to chlorinating wastewater effluents; however, many scientists have expressed a concern about the environmental impact and health effects of this process, particularly the effect of residual chlorine on fish and other aquatic life, and about the reaction of chlorine with organic materials in the effluents. These may form chlorinated hydrocarbons that persist in the environment, magnify through the food chain, and even cause cancer. A critical review of the literature and studies on quantifying the toxicity of chlorine to aquatic organisms showed that low concentrations of total residual chlorine (TRC) in wastewater are detrimental to aquatic life. A TRC concentration of 0.003 mg/l is safe for freshwater aquatic life continuously exposed to this residual; however, chlorine residuals in wastewater effluents and many receiving streams in Illinois exceed this safe concentration. The human cancer risk from chloroform found in drinking water appears to be low, but the risk from several carcinogens mixed together in water supplies and extrapolated from animal studies is not known. Epidemiologic studies have shown some association between gastro-intestinal and urinary tract cancer mortality and exposure to chlorinated drinking water. Most of these associations are not consistent across gender and race groups and generally are inconclusive. Research is needed on the transformation, metabolism, and bio-magnification of organochlorine compounds as they move through the food chain, and more epidemiologic studies are needed to clarify the risks of drinking chlorinated water. (Garrison-Omniplan)
W82-01451

ANAEROBIC CARBON FILTER FOR DEGRADATION OF PHENOLS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
M. T. Suidan, W. H. Cross, M. Fong, and J. W. Calvert.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No EE3, p 563-579, June,

1981. 10 Fig, 3 Tab, 15 Ref. OWRT-A077-6A(3), 14-34-0001-8011.

Descriptors: *Anaerobic digestion, *Activated carbon, *Phenols, Industrial wastes, *Wastewater treatment, Chemical oxygen demand, Methane, Catechol, Cresol, Mathematical equations.

An anaerobic activated carbon packer bioreactor was used to treat synthetic wastewaters bearing catechol, o-cresol, and a mixture of o-cresol and glucose. The process performance in converting the primary phenolic constituent as well as reducing the COD and organic content of the substrate was evaluated. Also, methane production was monitored. Chemical oxygen demand biomass yield coefficients of 11 to 15% were obtained. This low sludge productivity represents savings in sludge disposal costs. A methane gas production rate equivalent to 2.21 kcal/g of COD can be expected from the system. A mathematical expression which represents the relationship between wastewater characteristics that favor an anaerobic filter is $0.00457C - (35 - T) > 0$, where C = the concentration of biodegradable COD in milligrams/liter and T = the temperature of the raw wastewater in degrees C. (Small-FRC)
W82-01454

PURIFICATION OF MUNICIPAL WASTEWATER BY SUBSEQUENT REVERSE OSMOSIS AND ANAEROBIC DIGESTION,
Amsterdam Univ. (Netherlands). Lab. of Chemical Technology.
J. C. Van Den Heuvel, R. J. Zoetemeyer, and C. Boelhouwer.
Biotechnology and Bioengineering, Vol 23, No 9, p 2001-2008, September, 1981. 3 Fig, 3 Tab, 11 Ref.

Descriptors: *Reverse osmosis, *Anaerobic digestion, *Combined treatment, *Wastewater treatment, Municipal wastewater, Drinking water, Methane, Performance evaluation, Water quality.

The combined process of reverse osmosis followed by anaerobic digestion was applied to municipal wastewater. Membrane deterioration was studied in terms of permeate flux and rejection, and the quality of the permeate with respect to its possible use for the production of drinking water was determined. Also, the digestability of the brine by the anaerobic process and the amount of methane evolved were determined. The results of experiments were positive, with the permeate being a good quality as a raw material for drinking water. The wastewater was concentrated 7.7 fold, and continuous anaerobic digestion of the brine removed over 90% of the BOD, evolving the expected amount of methane. When environmental quality and the production of drinking water are considered, the combined process shows promise for highly populated areas which lack groundwater or surface water of good quality. (Small-FRC)
W82-01468

MECHANISM OF ENTEROVIRAL INACTIVATION BY OZONE.
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
D. Roy, P. K. Y. Wong, R. S. Engelbrecht, and E. S. K. Chian.
Applied and Environmental Microbiology, Vol 41, No 3, p 718-723, March, 1981. 5 Fig, 20 Ref.

Descriptors: *Wastewater treatment, *Viruses, *Ozone, Enterovirus, Poliovirus, Laboratory studies, Mirobiological studies, Disinfection, Kinetics.

The mechanism by which ozone inactivates viruses was elucidated using radiolabeled poliovirus 1 (Mahoney) to identify the major reactions and lethal sites involved. Residual ozone concentrations in viral suspensions were maintained at 0.3-0.8 mg/l to ensure at least 99% inactivation. Ozone had no effect on the overall structural integrity of the viral protein coat. Electrophoretic analysis of poliovirus capsid polypeptides labeled with 14C-amino acids suggested possible damage to two of the four polypeptide chains on the protein coat (VP1 and VP2), but the damage was insufficient to prevent attachment to host cells and thus to block viral replication. The sedimentation profile of centrifuged viral RNA extracted after exposure of labeled virus to 0.31 mg/l ozone for up to 2 min indicated damage to the RNA, which may have been fragmented into a number of short chains. Such damage would account for inactivation. This finding is consistent with studies showing that inactivation of viruses by ozone is rate limited by the diffusion of ozone through the protein coat and into the nucleic acid core. (Carroll-FRC)
W82-01482

STABILITY OF ACTIVATED SLUDGE PROCESSES BASED ON STATISTICAL MEASURES,
California Univ., Davis. Dept. of Civil Engineering.
S. Niku, and E. D. Schroeder.
Journal of the Water Pollution Control Federation, Vol 53, No 4, p 457-470, April, 1981. 4 Fig, 9 Tab, 16 Ref.

Descriptors: *Activated sludge process, *Statistical analysis, *Stability analysis, Wastewater treatment, Design criteria, Biological oxygen demand, Suspended solids, Contact stabilization, Standard deviation, *Wastewater facilities.

The stability of 43 activated sludge treatment plants was evaluated by statistical analysis. Standard deviation was selected as the most appropriate indication of stability in this study. Theroretically, it is a measure of dispersion, and practically, it is the most familiar and simplest term among the possible measures of stability--variance, coefficient of variation, and coefficient of stability. Plants were ranked with respect to stability, based on standard deviation vs. coefficient of stability of effluent BOD concentration and by standard deviation vs. coefficient of stability of effluent suspended solids (SS) concentration. Plants defined as stable operated at a standard deviation of less than 10 g per cu m for both effluent BOD and SS and a mean effluent BOD of less than 17 g per cu m, mean effluent SS less than 15 g pr cu m. There was little correlation between plant size and effluent quality. Examination of process type vs. stability revealed that the step feed or step aeration modifications of the conventional activated sludge process gave the best-year-round results for BOD removal; conventional activated sludge, for SS removal. The complete mix modification of the activated sludge and the contact stabilization process produces higher than average effluent BOD and SS concentrations, with the contact stabilization process having the worst performance characteristics. To achieve a stable activated sludge process plants should be designed for an effluent BOD concentration of less than 13-15 g per cu m and an effluent SS concentration of less than 1012 g per cu m. (Cassar-FRC)
W82-01489

EFFECT OF COPPER ON NITRIFICATION IN ACTIVATED SLUDGE,
Agricultural Univ., Wageningen (Netherlands). Dept. of Water Pollution Control.
For primary bibliographic entry see Field 5C.
W82-01497

OPTIMUM RECYCLE AND REUSE COOLING SYSTEM DESIGNS USING THE BCT PROCESS,
Tower Systems Inc., Tacoma, WA.
For primary bibliographic entry see Field 3E.
W82-01503

THE WAYNE COUNTY, MICHIGAN, WASTEWATER COLLECTION AND TREATMENT SYSTEM,
Wayne County Board of Public Works, MI.
D. R. Egeland, and T. G. Biehl.
Journal of the Water Pollution Control Federation, Vol 53, No 9, p 1366-1369, September, 1981. 3 Fig.

Descriptors: *Wastewater treatment, *Wastewater collection, Sludge, *Wayne County, *Michigan, Design criteria, Municipal wastewater, Wastewater management, Wastewater facilities.

A description is offered of the wastewater collection and treatment system in service for Wayne County, Michigan. Planning for the system began in the early 1930s; it currently serves a population of 1,100,000 in 39 municipalities located in 5 counties. Initial designs called for seven primary-treatment plants, together with intercepting sewers to convey the wastewater to the plants. Growth during the ensuing years resulted in the construction of two or more inland treatment plants and a large lagoon facility. Overall planning has been developed so as to use the large flow in the Detroit River to assimilate the treatment wastewater effluent and to protect the water quality of the smaller tributary rivers by eliminating wastewater treatment plant discharge. When the Huron Valley Project is completed, the Wayne County system will include the Northeast District, the Rouge Valley District and the Downriver District. The proposed Huron Valley plant features a biological treatment process involving a sequential anaerobic/aerobic environment that promotes the growth of organisms suitable for removing excess phosphorus as well as biochemical oxygen demand from the waste stream. The sludge disposal facilities consist of thickening in circular covered gravity tanks, sequential thermal conditioning and decanting of sludge, vacuum filtration with cloth media, fluid bed incinerators designed to achieve autogenous combustion of the thermally conditioned sludge with waste heat recovery, steam and electric power generation, and sidestream treatment, involving precipitation of phosphorus with lime. The Wayne County Board's largest plant treated an average of 85 mgd in 1980 at a basic charge of $552/million gallons. (Baker-FRC)
W82-01505

DETROIT - FRESH CLEAN WATER,
Detroit Water and Sewerage Dept., MI.
H. W. Bierig, A. C. Davanzo, J. W. Hubbell, and F. Pollard.
Journal of the Water Pollution Control Federation, Vol 53, No 9, p 1359-1369, September, 1981. 3 Fig.

Descriptors: *Wastewater treatment, *Detroit, Municipal wastewater, Municipal wastes, History, Water pollution control, Wastewater management, Combined sewers.

In 1836 a water pollution control program was begun for the city of Detroit with the construction of sewers that ran perpendicular to the river and emptied directly into it. The city continued to grow, and in 1914 a proposal was made to screen the combined sewer outfalls at the river's edge. In 1925 a comprehensive study proposed a plant near the southwestern corner of the city, with local topography and geological conditions being of key importance in planning one large treatment plant. Despite the flat terrain, almost 85% of Detroit is served by a gravity collection system, with pumping needed only at the treatment plant's main pump station. The other 15% of the city is served by combination sanitary/stormwater pump stations, remotely controlled from a central location in downtown Detroit. Although the combined system was constructed using mostly typical interceptor-level, float-controlled regulators, larger units at key locations have been modified for remote operation. The adverse effects of incoming rainfall can be reduced through reliance on weather forecasts. In 1969 it was decided to proceed with construction of two activated sludge systems. The first-phase construction of activated sludge systems included two intermediate variable-speed lift pumps, feeding the two aeration basins. Following aeration the flow proceeded to clarifiers, each with its own return sludge pump. While all this work was being undertaken in the Detroit area, other localities in the metropolitan region took their own approach to the collection and treatment of wastewater. (Baker-FRC)
W82-01506

DYNAMIC NUTRIENT CYCLE MODEL FOR WASTE STABILIZATION PONDS,
Princeton Univ., NJ. Dept. of Civil Engineering.
R. A. Ferrara, and D. R. F. Harleman.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil

Engineers, Vol 106, No EE1, p 37-54, February, 1980. 19 Fig, 2 Tab.

Descriptors: *Cycling nutrients, *Stabilization ponds, Ponds, Nutrients, *Wastewater treatment, Tertiary wastewater treatment, Advanced wastewater treatment, Model studies, Mathematical models, Optimum development plans, Design criteria.

A reliable and predictive method was sought for the optimum design and analysis of waste stabilization ponds that would go beyond the classical biochemical oxygen demand (BOD) approach and consider biological and nutrient dynamics. Attention is focused on facultative stabilization ponds, as they appear to be very promising and widely used for complete treatment of wastewater. In order to develop a usable model for waste stabilization ponds, it is necessary to describe both the hydraulic transport and the biological and chemical transformation of material. A model is developed which includes representation of the following: mineralization of organic compounds, organism growth, net loss of material by settling of nonbiodegradable organic matter, atmospheric reaeration of carbon dioxide, and removal of fecal coliforms by death and predation. Stabilization ponds are capable of providing at least secondary treatment of raw sewage while also removing significant amounts of nitrogen and phosphorus without process modification. While the use of stabilization ponds alone for high level tertiary treatment may not be feasible, they can, if properly designed in conjunction with solids removal mechanisms, provide a tertiary level of treatment. At present primary concern of future research on waste stabilization ponds should be in the area of data collection. (Baker-FRC)
W82-01541

SURVEY OF TREATMENT PLANT DESIGN AND OPERATION DEFICIENCIES,
Montgomery (James M.) Inc., Pasadena, CA.
D. L. Smith, and R. V. Daigh.
Journal of the Water Pollution Control Federation, Vol 53, No 8, p 1272-1282, August, 1981. 15 Fig, 1 Tab.

Descriptors: *Performance evaluation, *Process control, *Design criteria, *Wastewater treatment facilities, Operating policies, Training, Activated sludge, Clarification, Sludge disposal, Monitoring.

A survey of eight wastewater facilities with chronic operating problems revealed that the reasons for poor performance were evenly split between design and operation deficiencies. The most frequent design problems were grit removal/clarifier, pump control, and sludge handling systems. Of less importance were design loadings, reactor design, chlorine contact time, metering, and laboratory minor design details to cause severe operations problems. Inadequate monitoring was slightly more prominent among the operations deficiencies than other factors: staffing, inadequate maintenance, digester supernating/sludge withdrawal, return activated sludge operation, sludge pumping, infiltration/inflow industrial discharge, and aerator operation maintenance. Where chronic noncompliance at a plant is noted, emphasis should be placed on cause-effect relationships and controlled experimentation with process variables during operator training programs. (Cassar-FRC)
W82-01543

DESIGN AND COST COMPARISON OF BIOLOGICAL NITROGEN REMOVAL PROCESSES,
International Environmental Consultants Ltd., Toronto (Ontario).
R. W. Wilson, K. L. Murphy, P. M. Sutton, and S. L. Lackey.
Journal of the Water Pollution Control Federation, Vol 53, No 8, p 1294-1302, August, 1981. 2 Fig, 9 Tab, 18 Ref.

Descriptors: *Denitrification, *Nitrogen removal, *Biological treatment, *Wastewater treatment, *Penticton, British Columbia, Cost analysis, Design criteria, Nitrates, Ammonium, Land disposal, Ion exchange.

The most cost effective biological nitrogen removal process for the City of Penticton, British Columbia, was one-sludge pre-denitrification. This process uses the oxidizable organic matter in the raw wastewater as electron donor for the denitrification process. The process design was based on a 20-day aerobic solids retention time and a 10-day anoxic solids retention time at a minimum temperature of 8 C. Desired N levels in the treated effluent were 5 mgd per liter nitrate-N and 1 mg per liter ammonium-N. The one-sludge post-denitrification process was nearly as cost effective, followed by the two-sludge post-denitrification. Non-biological methods studied were ammonia stripping, ion exchange, and land disposal, all of which were 30-50% more expensive than the biological N removal processes. (Cassar-FRC)
W82-01544

PIPELINE FRICTION LOSSES FOR WASTEWATER SLUDGES,
Havens and Emerson Ltd., Cleveland, OH.
M. C. Mulbarger, S. R. Copas, J. R. Kordic, and F. M. Cash.
Journal of the Water Pollution Control Federation, Vol 53, No 8, 1303-1313, August, 1981. 16 Fig, 2 Tab, 18 Ref.

Descriptors: *Pipelines, *Friction loss, *Head loss, *Wastewater treatment, Pipe flow, Sludge, Rheology, Reviews, Shear stress, Turbulent flow, Laminar flow, Rigidity, Hydraulic loss, *Literature review.

The past 50 years' literature on frictional head losses associated with pipeline conveyance of wastewater solids was reviewed. The rheological data were summarized to discover trends as a function of the sludge slurry concentration. Trend lines were drawn to allow prediction of laminar flow head losses and the transition from laminar to turbulent flow regimes. Turbulent flow head losses obeyed conventional flow relationships. The head loss predictions divided into operating and worst case categories, were verified with operating data from several cities' treatment plants. Appended are predictive head loss curves for cast or ductile iron lines of seven diameters from 4 inches to 20 inches, representing both routine operation and worst case. (Cassar-FRC)
W82-01545

FACTORS AFFECTING THE FATE OF HEAVY METALS IN THE ACTIVATED SLUDGE PROCESS,
Oregon State Univ., Corvallis. Dept. of Civil Engineering.
P. O. Nelson, A. K. Chung, and M. C. Hudson.
Journal of the Water Pollution Control Federation, Vol 53, No 8, p 1323-1333, August, 1981. 12 Fig, 5 Tab, 34 Ref.

Descriptors: *Heavy metals, *Activated sludge process, *Adsorption, Water pollution effects, Wastewater treatment, Metals, Zinc, Copper, Bacteria, Cadmium, Microorganisms, Fate of pollutants, Toxicity.

Activated sludge bacteria rapidly adsorbed cadmium, copper, and zinc from solution within 1 hour after dosing in batch reactor experiments. Attempts to compare metal ion adsorption by live and inactivated bacteria produced erratic results; it is likely that physical and chemical factors, rather than biological factors, control the adsorption mechanism. Adsorption isotherms represented the distribution of metals between bacterial solids and solution phases. Conditional adsorption constants, presented in a table, indicated that Cu had a greater adsorption density than Cd at equivalent molar concentrations. As the pH increased, Cu adsorption increased up to pH 8, then decreased. The order of affinity for bacterial solids at pH 7 was Zn > Cu > Cd. pH was the single most important factor affecting metal adsorption on organic and inorganic surfaces. As pH increased, adsorption of Cd and Zn increased, reaching a maximum 90% removal at pH 10. Cu adsorption was almost 100% at pH 7, decreasing sharply to 40% or less at low and high pH. Adsorption of Cd, Cu, and Zn was greater at 5 days residence time than at 1 day, consistent with the hypothesis that exocellular polymers produced by the bacteria are largely responsible for uptake of metal ions. Solubilities, speciation, and distribution between the soluble and particulate (bacteria) phases were calculated from data obtained in this study and from the literature. (Cassar-FRC)
W82-01547

OPERATIONAL PROBLEMS WITH ROTATING BIOLOGICAL CONTACTORS,
Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD.
J. A. Hitdlebaugh, and R. D. Miller.
Journal of the Water Pollution Control Federation, Vol 53, No 8, p 1283-1293, August, 1981. 10 Fig, 5 Tab, 26 Ref.

Descriptors: *Nitrification, *Rotating biological contactors, *Performance evaluation, *Wastewater treatment, Ammonia, Solids contact processes, *Biological treatment, Chemical oxygen demand, Dissolved oxygen, Suspended solids.

Investigation into the cause of operating difficulties with a rotating biological contactor, part of a U.S. Army installation's 23,000 cu meters per day wastewater treatment plant, showed that the reasons for exceeding effluent limitations were different in summer and winter. In summer the poor performance was caused by low dissolved oxygen (less than 1 mg per liter) in the first four of six stages in the contactor. The white mass of Beggiatoa in the early stages indicated anaerobic conditions. Although very little soluble BOD remained after treatment, the suspended solids and ammonia exerted considerable oxygen demand. Supplemental oxygen and removal of suspended solids would allow more surface area for nitrification. Nitrification was limited both by low dissolved oxygen and low pH (6.5-6.7 vs. optimum 8.0-8.5). The winter difficulties were not a result of low dissolved oxygen but of low wastewater temperatures and too low pH. (Cassar-FRC)
W82-01549

HIGH TEMPERATURE ULTRAFILTRATION WITH KYNAR POLY(VINYLIDENE FLUORIDE) MEMBRANES,
Penwalt Corp., King of Prussia, PA. Technological Center.
W. D. Benzinger, B. S. Parekh, and J. L. Eichelberger.
Separation Science and Technology, Vol 15, No 4, p 1193-1204, 1980. 3 Fig, 3 Tab, 5 Ref.

Descriptors: *Waste water treatment, *Membrane filters, *Ultrafiltration, *Performance evaluation, Separation techniques, Industrial wastes, Textile mill wastes, Oxidation, Oxidized waste water, Organic solvents, Polymers.

Many commercial ultrafiltration membranes used in concentrating textile sizing wastes and other industrial wastes and in processing food products are damaged by drying, extremes of temperature and pH, organic solvents, and strong oxidants. An ultrafiltration membrane made from KYNAR poly(vinylidene fluoride) is described, which resists many of these elements. The membranes may be dried and rewetted or even autoclaved and still retain their integrity. Pilot plant studies were performed on simulated textile sizing wastes using spiral-wound modules made from these ultrafiltration membranes. Satisfactory performance of the membranes has been noted after continuous operation at 186 F and 20-25 psi for 7 months with flux rates up to 15 gallons/sq ft/day and 97% retention of the poly(vinyl alcohol). (Geiger-FRC)
W82-01566

APPLICATION OF AERIAL PHOTOGRAPHS AND SURFICIAL GEOLOGIC MAPS TO THE DETERMINATION OF SUITABILITY OF LAND FOR SEPTIC TANK SYSTEMS,
Federal Energy Regulatory Commission, Washington, DC.
For primary bibliographic entry see Field 7B.
W82-01569

OPEN-PORE POLYURETHANE AS A MEDIUM FOR COAL CONVERSION PROCESS AQUEOUS EFFLUENT CLEANUP,
Oak Ridge National Lab., TN. Chemical Technology Div.
M. S. Denton, S. R. Dinsmore, J. I. Brand, and J. Beams.
Separation Science and Technology, Vol 15, No 3, p 587-613, 1980. 13 Fig, 3 Tab, 14 Ref.

Descriptors: *Wastewater treatment, *Absorption, *Polymers, *Synthesis, Separation techniques, Industrial wastes, Liquid wastes, Electron microscopy, Graphical methods, Cleanup, Coal conversion wastewater.

In coal conversion processes, polymerized open-pore polyurethane is often used as a medium for the cleanup of aqueous effluents. Optimum conditions for synthesizing open-pore polyurethane (OPP) were investigated in situ by varying the reaction conditions and studying OPP structures by electron microscopy and flow-rate tests. Under these conditions, large 1-inch by 12-inch columns were polymerized and compared with identical columns filled with three common commercial adsorbents (a petroleum-based activated charcoal, a carbonaceous adsorbent and XAD-2) using a four-column, bench-scale adsorption apparatus. For each column, breakthrough curves of a synthetic and an actual coal conversion waste water were plotted. OPP was intermediate in capacity for synthetic effluent adsorption between XAD resin and carbon adsorbents, and phenol breakthrough was minimal. The in-situ polymer was more readily eluted with solvent than the other sorbents. OPP efficiency for carbonizer aqueous scrubber adsorption was somewhat lower, possibly because of the low phenol content. (Geiger-FRC)
W82-01577

O2 BLEACHING SHOWS POTENTIAL FOR REDUCING COSTS AND EFFLUENT PROBLEMS,
North Carolina State Univ. at Raleigh. Dept. of Pulp and Paper Science.
H-M. Chang.
Pulp and Paper, Vol 54, No 3, p 87-91, March, 1980. 4 Fig, 20 Ref.

Descriptors: *Pulp and paper industry, *Oxygen, *Bleaching wastes, Closed systems, Pollutant load, Water pollution control, Water quality standards, Industrial wastes, Economic aspects.

Oxygen bleaching processes are the only commercially proven alternatives that significantly reduce pollutant load and effluent volume in pulp and paper mills. The basic process is reviewed, and the major advantages and disadvantages are discussed. Oxygen bleaching is a modular operation between the digesters and conventional bleach plant. It continues delignification and removes about 50% of the residue lignin from the pulp. Because the oxygen bleaching effluent can be integrated into the closed cycle of the pulp mill chemical-recovery system, up to 50% of the total organic load in the bleach plant effluent can be eliminated. Oxygen bleaching may be the most cost-effective method of meeting anticipated stringent effluent standards. The system does entail high capital costs, as it requires expensive equipment which must be fabricated from stainless steel to avoid corrosion problems. Also, special safety considerations are required to monitor and control buildup of explosive vapors and gas. (Small-FRC)
W82-01578

CLOSEUP OF WHITEWATER SYSTEM HELPS MENASHA MEET EFFLUENT STANDARDS,
Menasha Corp., Otsego, MI.
B. Buchanan.
Pulp and Paper, Vol 54, No 3, p 60-62, March, 1980. 3 Fig, 1 Tab.

Descriptors: *Pulp and paper industry, *White water, *Water reuse, Industrial wastes, Closed systems, Industrial plants, Water quality standards.

Closeup of the whitewater system was implemented at a 360 tpd non-sulfur corrugating medium mill in order to meet effluent standards. Whitewater was screened for long fiber removal, and an in-line turbine flowmeter network was installed in the freshwater system, while daily mill balances were run on the computer. The system had a relatively low cost, modular construction, short installation time, positive long-fiber protection for critical reuse areas, and the capability to handle a high feed solids loading. A Sinclair Float Wash FD6 fractionator was used. The next phase of the mill closeup program will be to replace the following current freshwater-supplied items on fractionated whitewater: pulp, refiner and agitator seals, deck and vibrating flat screen showers, breast roll showers, and trim knockoff showers. Satisfactory performance of the fractionator and satisfactory response of the paper machine to the fractionated water have made the initial closeup a success. (Small-FRC)
W82-01579

TREATMENT OF SEWAGE PLANT EFFLUENT FOR USE AS MAKEUP WATER,
Burbank, CA.
For primary bibliographic entry see Field 3C.
W82-01585

ROSARIO DOMINICANA'S CYANIDE TAILINGS DAM CONSTRUCTION AND OPERATION.
Martiki Coal Corp., Denver, CO.
R. Addison, and R. O. Cranor.
Mining Engineering, Vol 33, No 6, p 709-714, June, 1981. 12 Fig, 4 Tab.

Descriptors: *Tailings, *Mine wastes, *Waste water treatment, *Dam construction, Surface runoff, Dam design, Cyanide, Diversion dams, Mine drainage, Gold, Silver, Gravity dams, Reclaimed water, Separation techniques, Relief, Wells, Diversion structures, *Dominican Republic.

The construction and operation of a tailings dam in the Dominican Republic are described. The dam is located downstream from an 8.5 kt/d open pit gold/silver mine located in an agricultural area subject to earthquakes and heavy rainfall. Incorporated into the core of the dam is a vertical gravel filter drain which discharges into the horizontal drainage blanket that extends to the downstream toe of the embankment. This arrangement prevents saturation of the downstream half of the dam wall. Relief/observation wells were drilled at critical points along the downstream toe to allow for seepage through the limestone foundation and to relieve uplift pressures. Tailings from the mill are discharged from a 4-train countercurrent decantation (CCD) thickener system after cyanide extraction of gold and silver. A water reclamation system was set up for use as wash on the last thickener of the CCD train. The alkalinity of the reclaim water serves to bind dust on road surfaces, and the reclaim water storage tank provides reserve water for the fire pump. A polyvinyl chloride pipe was used to divert a runoff stream from the dam to the Mejita River. (Geiger-FRC)
W82-01589

TREATMENT OF PULP AND PAPERMILL WASTEWATERS AND THE USE OF THE OXYGEN ACTIVATED SLUDGE SYSTEM,
R. W. Fuggle.
Effluent and Water Treatment Journal, Vol 21, No 6, p 259-262, 266-269, June, 1981. 3 Fig, 5 Tab, 10 Ref.

Descriptors: *Pulp and paper industry, *Unox process, *Oxygenation, Ozonation, *Wastewater treatment, Industrial wastewater, Activated sludge process.

The oxygen activated sludge process, or Unox process, is used to treat wastewaters at 24 pulp and paper mills worldwide. The basis of this process is economical separation of oxygen from air on site and a covered tank divided into compartments, providing a series of completely mixed stages and retaining the characteristics of the plug flow reactor. This process has several advantages over air aeration: more efficient contact of oxygen with sludge, saving power; a more stable, better-settling biomass; reduced retention time; better performance under shock loads; decreasing oxygen costs with increasing size of generator; better odor control; and use of oxygen in additional plant processes. Pilot plant and bench scale studies of this process were carried out in several countries widely varying wastewater types. The following conclusions were reached: (1) 90% of BOD can be removed at sludge loadings up to 1 kg BOD per kg MLVSS, (2) a large proportion of suspended solids are inert to biological treatment, especially in sulfite pulping mills, (3) the system was sensitive to the high temperatures (50C) encountered, (4) the Unox process handled shock loadings and mill shutdowns with greater stability, (5) caustic was required for pH maintenance, and (6) fish toxicity tests showed a 90% survival in treated effluent vs. zero in untreated kraft mill effluent. The use of ozone as a chlorine substitute, as a tertiary treatment, and in managing sulfide odors is in the research stage. (Cassar-FRC)
W82-01594

LAND TREATMENT SITE EVALUATION IN SOUTHEASTERN MOUNTAINOUS AREAS,
Law Engineering Testing Co., Marietta, GA.
G. L. Taylor, Jr.
Bulletin of the Association of Engineering Geologists, Vol 18, No 3, p 261-266, August, 1981. 4 Tab, 12 Ref.

Descriptors: *Wastewater treatment, *Municipal wastewater, *Land disposal, *Site selection, Waste disposal, Wastewater disposal, Hydraulic loading, Environmental effects, Design criteria, Percolation, Evapotranspiration, Mathematical studies.

The treatment of municipal waste water by application to land offers an alternative to in-plant treatment which eliminates the environmental impact of direct discharge to surface waters. The site for land treatment must take into account soil, climatic, geologic, hydrologic and vegetation factors. The hydrologic budget evaluation consisting of investigations of design precipitation, evapotranspiration, percolation of water to groundwater, and waste water hydraulic loading must also be performed. Seventeen site selection guidelines are presented and divided into two groups according to their impact on the site selection process. In addition, computation of a hydraulic loading range allows comparison of different land treatment sites and enables evaluation of the feasibility of land treatment with respect to other alternate treatments on a preliminary basis. (Geiger-FRC)
W82-01596

5E. Ultimate Disposal Of Wastes

ARTIFICIAL GROUNDWATER RECHARGE,
Water Research Centre, Marlow (England).
For primary bibliographic entry see Field 4B.
W82-01110

INFRARED SPECTROSCOPIC STUDY OF THE WATER-SOLUBLE FRACTION OF SEWAGE SLUDGE-SOIL MIXTURES DURING INCUBATION,
Sonoma State Univ., Rohnert Park, CA. Dept. of Chemistry.
G. D. Schaumberg, C. S. LeVesque-Madore, G. Sposito, and L. J. Lund.
Journal of Environmental Quality, Vol 9, No 2, p 297-303, April-June, 1980. 6 Fig, 2 Tab, 27 Ref.

Descriptors: *Sludge disposal, *Sludge digestion, *Soil water, *Alkaline soils, *Acidic soils, Wastewater disposal, Soil amendments, Soil organic matter, Biodegradation, Anaerobic digestion, Infrared spectroscopy, Degradation, Decomposition, Nitrates, Sulfates.

Four soil-sludge mixtures prepared from two anaerobically digested sewage sludges and two sandy soils with different pH's were maintained at two different levels of soil water content for 100 weeks at 250 degrees under laboratory conditions. Sludge decomposition was monitored by infrared spectra

of evaporated films prepared from extracts taken periodically from the mixtures. In alkaline soil maintained at 1/3-bar soil water tension, and for both sludges, polysaccharides, proteinaceous material, and sulfonate and/or sulfate compounds disappeared after about 10 weeks. During the same time, carboxylates and nitrates appeared or increased in intensity. Similar changes occurred in the alkaline soil maintained at water saturation, but at a much slower pace. IR spectral changes in the acidic soil maintained at 1/3-bar soil water tension were also slightly retarded. The extracts of acidic, water-saturated soil incubated with either sludge gave the least amount of spectral changes. (Geiger-FRC)
W82-01130

DEMONSTRATION TESTING OF ALUM RECOVERY BY LIQUID ION EXCHANGE,
Michigan State Univ., East Lansing. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W82-01167

STUDIES ON UNSATURATED ZONE HYDROLOGY AND RADIONUCLIDE MIGRATION AT A SHALLOW-LAND BURIAL SITE,
California Univ., Berkeley, Dept. of Plant and Soil Biology.
For primary bibliographic entry see Field 5B.
W82-01172

SLUDGE TREATMENT, UTILIZATION, AND DISPOSAL,
Duke Univ., Durham, NC.
P. A. Vesilind.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 726-733, June, 1981. 173 Ref.

Descriptors: *Literature review, *Bibliographies, *Sludge disposal, Wastewater treatment, Sludge utilization, Wastewater management, Public health, Legal aspects.

A literature review is presented of 1980 publications on sludge treatment, utilization, and disposal. Environmental Protection Agency regulations on the manufacture of sludge-derived products were reviewed, and several papers dealt with energy considerations in sludge management. Optimization of sludge management techniques was explored in studies which included the development of a computer program which permitted the selection of various sludge handling unit operations. The importance of public opinion in sludge management alternatives selection was emphasized by one paper. Waste activated sludge processing was investigated, and the most cost effective system was dissolved air flotation, mesophilic digestion, centrifugal dewatering, compost drying, and sale of the final product. Safety hazards in sludge processing were examined in one article. This included the health risks associated with producing food chain substances out of the sludge. General areas covered by the publications were: sludge properties; industrial, nutrient-laden, and water treatment sludges; thermal conditioning and incineration; thickening; dewatering; stabilization; and ultimate disposal and utilization. (Small-FRC)
W82-01247

ONSITE ALTERNATIVES FOR TREATMENT AND DISPOSAL,
Wisconsin Univ.-Madison.
For primary bibliographic entry see Field 5D.
W82-01248

A STUDY OF REGIONAL TEMPERATURE AND THERMOHYDROLOGIC EFFECTS OF AN UNDERGROUND REPOSITORY FOR NUCLEAR WASTES IN HARD ROCK,
California Univ., Berkeley. Lawrence Berkeley Lab.
J. S. Y. Wang, C. F. Tsang, N. G. Cook, and P. A. Witherspoon.
Journal of Geophysical Research, Vol 86, No B5, p 3759-3770, May, 1981. 17 Fig, 4 Tab, 18 Ref.

Descriptors: *Waste disposal, *Radioactive wastes, *Groundwater movement, *Thermodynamics, Temperature effects, Density, Viscosity, Transmissivity, Geologic fractures, Environmental effects, Toxicity.

Three important aspects of the design and performance of underground respositories for the disposal of nuclear wastes were investigated. First, heat released by the radioactive decay of the nuclear wastes causes changes in the temperature distribution in the rock which produce thermally induced components of compressive stress in the heated rock and tensile components of stress outside of this zone. Second, the magnitude and temporal changes of the temperatures in the rock are affected by the type of waste and the time it is buried, and the characteristics of different wastes are discussed. Third, the temperature changes in the rock affect the density and viscosity of water. These changes in the temperature of groundwater may result in perturbations of the hydrologic flow which in turn may affect the isolation of toxic components of the waste. A model is presented of buoyancy groundwater flow through a simple fracture system. This flow is a function of vertical and horizontal fracture transmissivities as well as changes in groundwater density and viscosity. (Small-FRC)
W82-01347

THE INFLUENCE OF CHEMICAL CONDITIONING AND DEWATERING ON THE DISTRIBUTION OF POLYCHLORINATED BIPHENYLS AND ORGANOCHLORINE INSECTICIDES IN SEWAGE SLUDGES,
Imperial Coll. of Science and Technology, London (England). Dept. of Public Health Engineering.
A. E. McIntyre, J. N. Lester, and R. Perry.
Environmental Pollution, Series B, Vol 2, No 4, p 309-320, 1981. 6 Tab, 27 Ref.

Descriptors: *Polychlorinated biphenyls, *Insecticides, *Sludge conditioning, *Chlorinated hydrocarbons, Pollutant identification, Organic compounds, Pesticides, Dieldrin, Gamma-HCH, Aroclors, Land application, Sludge disposal, Dewatering, Path of pollutants, Water pollution sources.

Polychlorinated biphenyls and organochlorine insecticides were associated with the solid matter in sewage sludge, according to mass balances derived for these materials in two treatment works. One process involved coagulation of primary digested sludge with aluminum chlorohydrate followed by dewatering using vacuum filtration; the other, conditioning of consolidated mixed primary sludge with Zetag 94S, an organic polyelectrolyte, and subsequent dewatering by pressure filtration. The dewatering chemicals did not interfere with analysis of the organochlorine compounds in conditioned sludges. Using either Aquafloc 4051 or Zetag 94S the ranges (in micrograms per liter) were: Aroclor 1260, 3.14-3.74; p,p'-DDE, 1.04-1.54; gamma-HCH, 6.54-8.60; and dieldrin, 7.72-9.00. In the filtrates from the vacuum filtration plant and the pressure filtration plant no Aroclor 1260, gamma-HCH, or p,p'-DDE was detected. The vacuum process filtrate contained 0.007-0.026 micrograms per liter dieldrin and the pressure filtration filtrate, 0.008-0.012 micrograms per liter dieldrin. Concentrations of organochlorines in sludge cakes (micrograms per g) were: Aroclor 1260, 0.25-0.51; p,p'-DDE, 0.04-0.05; gamma-HCH, 0.13-0.16; and dieldrin, 0.15-0.17. (Cassar-FRC)
W82-01387

THE NATIONAL ASSESSMENT OF THE GROUND-WATER CONTAMINATION POTENTIAL OF WASTEWATER IMPOUNDMENTS,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W82-01419

COMPARATIVE EVALUATION OF PROCESSES FOR THE TREATMENT OF CONCENTRATED WASTEWATERS AT UNCONTROLLED HAZARDOUS WASTE SITES,
TRW Environment Engineering Div., Redondo Beach, CA.
For primary bibliographic entry see Field 5D.
W82-01430

STABILIZATION/SOLIDIFICATION OF WASTE FROM UNCONTROLLED DISPOSAL SITES,
Army Engineer Waterways Experiment Station, Vicksburg, MS.
P. G. Malone, R. J. Larson, and T. E. Meyers.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 180-183, 1 Fig, 2 Tab, 10 Ref.

Descriptors: *Land disposal, *Waste disposal, *Hazardous materials, *Water pollution prevention, Toxicity, Metals, Anions, Organic compounds, Landfills, Incineration, Portland cements, Asphalt, Polymers, Adsorption, Waste disposal sites.

Stabilization/solidification can be employed as a step to facilitate safe transport and disposal of the wastes at the estimated 2000 unauthorized or uncontrolled sites in the U.S. Stabilization/solidification is appropriate for both on-site and off-site ultimate disposal, and has cost and safety advantages over drum overpacks. Once the liquid wastes have been identified and characterized by their major constituents the stabilization/solidification process may be chosen. Admix techniques using Portland cement, organic polymers or other binding agents are most suited to toxic metal wastes. Thermoplastic incorporation into asphalt, sulfur or polyethylene, and encapsulation in an inert jacket are suitable disposal techniques to contain soluble toxic dry salts and toxic anions. Toxic organics can be adsorbed onto clays, but their continued volatilization must be prevented by some sort of vapor-tight barrier. All the stabilized wastes may be recontainerized and landfilled since they no longer threaten to contaminate ground or other water resources. The stabilized organics may also be incinerated. (Brambley-SRC)
W82-01432

IDENTIFICATION AND RECLAMATION OF CHROMIUM SLUDGE DISPOSAL SITES,
Maryland Office of Environmental Programs, Annapolis.
W. L. Ramsey.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 259-261, 2 Fig, 2 Tab, 4 Ref.

Descriptors: *Sludge disposal, *Chromium, *Groundwater pollution, *Land disposal, Monitoring, Soil contamination, Sludge bed, Water pollution control, Wastewater treatment, Industrial wastes, Organic solvents, *Sludge treatment.

In 1978 an Interim Facility Permit was issued in Maryland to a company requiring it to develop a new technique for handling chromium sludge and a plan to renovate existing sludge beds. Twenty-five wells were located in the area; water from them was analyzed. Chromium levels up to 276 ppm were reported. Monitoring wells were dug around the sludge beds. The ground water was found to be contaminated to a level of 0.25 ppm, but the direction of groundwater was found to be southeast, and not the anticipated southwest. In searching for additional monitoring well sites, another dump was discovered which was the major source of contamination. The sludge beds were renovated by removing contaminated soil to bedrock and hauling it to a safe site. The area was backfilled, contoured and stabilized, and within 2 months the groundwater in the monitoring wells closest to the site showed declines in chromium from 0.25 ppm to 0.001 ppm. The dimensions of the new dump were determined by taking core samples and placing sampling wells. Traces of organic solvents were found. The heavily contaminated soil will be removed down to the bedrock, and the site will be capped with clay, regraded and

stabilized. The company has installed a new wastewater treatment system which reduces the volume of sludge. The sludge is transported to a safe disposal facility. (Brambley-SRC)
W82-01437

EFFECTS OF SANITARY LANDFILL LEACHAGE ON SOME SOIL CHEMICAL PROPERTIES,
Science and Education Administration, Morgantown, WV.
W. M. Winant, H. A. Menser, and O. L. Bennett.
Journal of Environmental Quality, Vol 10, No 3, p 318-322, July-September, 1981. 6 Tab, 21 Ref.

Descriptors: *Soil chemistry, *Leachages, *Sanitary landfills, Landfills, Chemical properties, Soil properties, Wastewater treatment, Effluents, Land disposal, Chemical composition.

Land disposal by spray irrigation has been successfully used to treat leachate from sanitary landfills through substantial reductions in chemical oxygen demand, electroconductivity, and total nutrient content of the leachate. Soil chemical analyses were performed to determine the efficacy of land disposal used in conjunction with soil amendments as a method for decontamination of leachage from a sanitary landfill. Experimental plots received leachage only or leachate plus lime, rock phosphate, or superphosphate. The plots received about 100 centimeters of leachage from a sanitary landfill over a 6-month period, after which soil samples were collected to a depth of 60 centimeters. Application of the fertilizers and leachage in combination to woodland soils significantly increased the extractable soil calcium, magnesium, potassium, strontium, and zinc levels as compared with pre-irrigation values at a soil depth of 0 to 5 centimeters. Extractable manganese was significantly higher at soil depths of 30 centimeters in all of the leachate-treated plots as compared with pre-irrigation values. Iron, phosphorus, and Kjeldahl nitrogen levels were not significantly changed by leachate irrigation. Soil pH was increased from 4.7 to 5.8 at the 0 to 5 centimeter depth and from 4.5 to 5.7 at the 15 to 30 centimeter depth by irrigation with leachate. Although most elements were attenuated to some extent by the soil, lime and fertilizer addition did little to influence soil absorptive capacity. (Carroll-FRC)
W82-01480

VEGETATION SELECTION AND MANAGEMENT FOR OVERLAND FLOW SYSTEMS,
Cold Regions Research and Engineering Laboratory, Hanover, NH.
A. J. Palazzo, T. F. Jenkins, and C. J. Martel.
Public Works, Vol 112, No 8, p 49-52, August, 1981. 2 Tab, 5 Ref.

Descriptors: *Overland flow, *Vegetation, *Crop yields, *Land disposal, Flow, Wastewater disposal, Agriculture, Nutrients, Nitrogen, Phosphorus, Grasses.

Domestic wastewater was applied over a four-year period at various rates to study plant growth and nutrient removal on each of three overland flow test slopes. Establishment of forage grasses, plant yields, and uptake of nutrients were determined. Domestic sewage from the town of Hanover, New Hampshire, was applied weekly, with each weekly application period spanning a five-day period, seven hours per day. The waste contained an average of 35 mg/liter of total nitrogen and 6 mg/liter of total phosphorus. Annual plant yields on a dry weight basis for a minimum of two harvest periods ranged from 3.4 to 5.4 tons/acre. This was almost three times the average yield of hay grown in the state. None of the concentrations of elements measured in the harvested plants was in the deficiency or toxicity ranges, indicating growth of healthy plants. Reed canary grass, orchard grass, and tall fescue all had good persistence on the overland flow slopes. (Small-FRC)
W82-01500

ELECTRO-OSMOSIS CHEMISTRY AND WATER QUALITY,
Lowell Univ., MA.
B. A. Segall, C. E. O'Bannon, and J. A. Matthias.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No GT10, p 1148-1152, October, 1980. 1 Fig, 1 Tab, 4 Ref.

Descriptors: *Waste disposal, *Dewatering, *Electro-osmosis, *Slope stabilization, Waste management, Separation techniques, Membrane processes, Electrochemistry, Electrodes, Anodes, Cathodes, Water quality, Soil water, Dredging.

Studies were made on the feasibility of using electro-osmosis to increase the capacity of dredged material disposal sites by reducing the water content of in-place material and increasing the shear strength of containment area embankment foundations. Some theories on the electrochemical process of electro-osmosis which may be used to improve the process for application in slope stabilization and foundation dewatering are reported. The chemical characteristics of electro-osmosis process water, which may become an environmental pollutant, are presented. Electro-osmosis water is highly alkaline, contains organic material, is highly colored, and may contain high levels of pesticides, heavy metals, or other substances from the soil or water mass. Moving the electrodes during electro-osmotic dewatering was effective in reducing polarization and increasing the rate of dewatering. This procedure has the added advantage of enabling dewatering of an entire soil mass when needed for a particular application. (Geiger-FRC)
W82-01518

REMEDIAL ACTION CONTROLS GROUNDWATER CONTAMINATION AT A PAPER MILL SLUDGE DISPOSAL SITE,
Soil Testing Services of Wisconsin, Inc., Green Bay.
For primary bibliographic entry see Field 5G.
W82-01582

5F. Water Treatment and Quality Alteration

THE PROBLEMS OF NON-RETURN AND THE USE OF VALVES IN DRINKING WATER PROTECTION AGAINST WASTE WATER RETURN, APPLYING THE REGULATIONS IN FORCE,
B. Rochette.
Aqua, No 2, p 27-31, 1980. 4 Fig, 2 Tab.

Descriptors: *Hydraulic valves, *Return flow, *Wastewater management, Water distribution, *Drinking water, Water pollution control, Flow regulations, Water mains, Pressure head, Regulations, Water pollution sources, *Water supply systems.

Many cases of wastewater entering the water distribution system have been reported in European cities. Common causes of this problem are lowering of main pressure caused by large demand, repairs, and breakage; and high pressure systems on the consumer end. Most European countries have regulations for preventing return flow. Check valves are often used to control the problem. The linear parallel displacement valve fulfills conditions specified by most legislatures. Minimum and maximum requirements are described for mechanical characteristics of the casing, tightness (must be tight for 3-10 min at 3 cm water column pressure and from 0-16 bars), head loss, and reliability (must work through 100,000 cycles of operation) of non-return valves. (Cassar-FRC)
W82-01142

CHEMICAL EQUILIBRIA IN SPLIT-TREATMENT SOFTENING OF WATER,
Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Civil Engineering.
K. A. Zipf, Jr., and R. G. Luthy.
Journal of the American Water Works Association, Vol 73, No 6, p 304-311, June, 1981. 8 Fig, 5 Tab, 11 Ref.

Descriptors: *Water softening, *Equilibrium, *Split treatment, Hardness, Calcium compounds, *Water treatment, Lime, Sodium carbonate, Chemical reactions, Langlier equations, Saturation index, Carbonates, Water quality.

Equations and methods of solution are developed for split treatment water softening problems in order to see how treated water quality parameters and operating variables are related to chemical requirements. Split treatment, generally applied to high-Mg waters, divides the raw water into two streams, one treated with excess lime, and the other bypassed or untreated. These streams are recombined and treated with soda ash for noncarbonate hardness removal. Both the lime softening process (9 equations, 12 variables) and the lime-soda ash process (10 equations, 12 variables) may be solved by assigning values to two decision variables. The soda ash dosage is zero in the one treatment. Solution sets are described for the decision variables combinations as follows: effluent hardness and pH, effluent alkalinity and pH, lime dose and bypass fraction. Several examples of computer-aided graphical solutions are presented. The bypass fraction may be raised from about 0.25 to about 0.90. Effective minimum effluent pH is 7.8-8.0. There is usually a minimum associated with chemical costs and effluent quality variables. The hydroxide concentration is usually a limiting figure in split treatment. (Cassar-FRC)
W82-01165

INTERPRETING LABORATORY RESULTS FOR THE DESIGN OF RAPID MIXING AND FLOCCULATION SYSTEMS,
Servicos de Engenharia Emilio Baumgart Ltd., Belo Horizonte (Brazil).
J. R. Bratby.
Journal of the American Water Works Association, Vol 73, No 6, p 318-325, June, 1981. 11 Fig, 2 Tab, 21 Ref.

Descriptors: *Flocculation, *Coagulation, *Mixing, *Water treatment, Alum, Turbidity, Settling velocity, Polyelectrolytes, Laboratory tests, Brazil.

A 3-liter laboratory batch reactor for measuring flocculation under rapid mixing conditions is described. The raw water was obtained from the Lago Descoberto, Brazil water supply. Optimum conditions derived from using this batch reactor were: primary coagulant--3 mg per liter alum at pH 6.4; rapid mixing velocity gradient--650 per sec for 0.5 to 8 sec; anionic polyelectrolyte--0.15 mg per liter; preflocculation--3 equal volume tanks, velocity gradients 100 per sec each, total retention time 20 min; flocculation system--3 tanks with velocity gradients, 100 per sec, 50 per sec, and 30 per sec, respectively; total retention time, 31.5 min; settling overflow rate, 9 cm per min with effluent quality of 0.5 ftu; design overflow 6 cm per min. (Cassar-FRC)
W82-01166

DISINFECTION,
Georgia Inst. of Tech., Atlanta.
For primary bibliographic entry see Field 5D.
W82-01250

MICROBIOLOGY OF POTABLE WATER,
Environmental Protection Agency, Dallas, TX. Region VI.
M. J. Allen.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 1109-1112, June, 1981. 42 Ref.

Descriptors: *Microbiological studies, *Potable water, *Literature review, *Bibliographies, Drinking water, Domestic water, Viruses, Bacteria, Water distribution, Water quality.

A literature review is presented of 1980 articles on the microbiology of potable water. Research included an evaluation of the use of granular activated carbon whicch identified needed research including investigation of the factors responsible for the initiation of microbial growth on GAC surfaces and the microbial generation of organic compounds during carbon treatment. A study on the

inactivation of cell-associated poliovirus and coxsackievirus found that higher ozone residuals were required than for nonassociated viruses. Also, natural poliovirus isolates found in drinking water were more resistant to chlorine inactivation than were standard laboratory virus strains. One study examined 23 potable water supplies for viruses and found ten virus positive samples. An investigation of water encrustations from seven water systems by scanning electron microscopy found algae, actinomycetes, diatoms; and filamentous and flagellated bacteria. Several studies supported the concept that microorganisms promote a localized corrosion of metal and tubercle formation, and that the microbial ecosystems influence the concentrations of numerous constituents in distributed waters. (Small-FRC)
W82-01287

MALAWI: A COMMUNITY APPROACH.
UNESCO Courier, Vol 34, No 2, p 16-17, February, 1981.

Descriptors: *Water supply development, *Public participation, *Malawi, Developing countries, *Water distribution, Drinking water, Africa.

Clean water is now available to 70% of urban dwellers and 35% of the rural inhabitants in Malawi, population 5 million. Local involvement has been responsible for this progress toward the government's goal of safe, potable water within 400 meters for all people by 1990. As an example, the Mulanje West Project is described. When shallow wells and the nearby river periodically failed after extensive tree removal, the government designed a water distribution system, and the villagers provided construction labor. About 200 men, women, and children worked enthusiastically on digging trenches for 30 km of main line and 210 km of branch lines, as well as installing concrete aprons and drains for the taps. In other areas where shallow wells are appropriate, villagers supply bricks, sand, oxcarts, and labor, and the government provides pumps and concrete slabs. In cities, water projects are financed by water charges. (Cassar-FRC)
W82-01365

THE RIVER OUSE WATER SUPPLY SCHEME,
Yorkshire Water Authority (England).
R. Dobson.
Journal of the Institution of Water Engineers and Scientists, Vol 34, No 3, p 265-290, May, 1980. 7 Fig, 3 Tab.

Descriptors: *Water treatment facilities, *Construction, *Yorkshire Water Authority, Water resources development, Ouse River, Political aspects, Social aspects, Reservoirs, Pipelines, Pumping plants, Planning, Rivers, *England.

The background, planning, and construction of a large water source development on the River Ouse in Yorkshire, England, is described in detail. The facilities consisted of abstraction works, pumping station, a 28.6 km pipeline, and a reservoir bypass. Although planning began in the late 1960's the drought of 1975-76 was a factor in deciding in October 1976 to build the plant as quickly as possible. Water was pumped from the river only 18 months after detail design commenced and 11 months after construction contracts were let. Overall costs were 10,000,000 pounds. Some of the noteworthy details involved in the project were: (1) the raw water has wide variations in hardness (65 to 290 mg per liter) and a rich nutrient supply, (2) river flooding is frequent and widespread, (3) a 48-hour storage channel protects the supply from pollution, (4) landowners objected to installation of power transmission lines and pipeline construction, (5) delivery of construction materials and equipment was closely monitored to prevent delays, (6) the abstraction works land was owned by a fishing club, (7) the pipeline route had to be adjusted so archaeologists could study two medieval villages, and (8) excavation in hard sandstone near the reservoir was simplified by threading the bypass pipe through an unused 40 inch diameter cast iron pipe laid in 1847. (Cassar-FRC)
W82-01371

DEVELOPMENTS IN SEDIMENTATION AND FLOTATION,
Water Research Centre, Stevenage (England).
T. F. Zabel.
Effluent and Water Treatment Journal, Vol 21, No 4, p 166, 168-169, 172, April, 1981. 2 Fig, 1 Tab.

Descriptors: *Sedimentation, *Flotation, *Suspended load, Drinking water, Flocculation, *Water treatment, Performance evaluation, Pilot plants, Rivers, Water treatment facilities, *Great Britain.

Lamella sedimentation and flotation are developments which increase the surface loadings of water treatment plants. In co-current or down-flow lamella sedimentation systems developed in Sweden, the flocculated suspension passes in laminar flow from the surface downwards through a system of parallel plates. Flocculated particles settle on the plates and run smoothly down to the sludge collector. The clarified water is withdrawn at the bottom of the plates. In the counter-current system, the flocculated water enters from the sides at the lower edge of the lamellae through channels and moves upwards between the lamellae. Again, the particles settle on the plates and slide down into the sludge collector. This system has a simpler design and was tested in a pilot plant on the Thames River. The process can be operated up to 30 m/hr and produces acceptable settled water for further treatment by rapid gravity filtration. The most likely application for lamella sedimentation is the treatment of lowland river waters with heavy solids loads. Flotation is particularly effective for stored waters containing high algal loads or low turbidity, highly colored waters. There are approximately 20 flotation plants operating in the United Kingdom, which range in size from 2.3 to 36 M liter/day. (Small-FRC)
W82-01391

REGENERATION OF ANION EXCHANGE RESINS BY CALCIUM CARBONATE AND CARBON DIOXIDE,
Kernforschungszentrum Karlsruhe (Germany, F.R.).
W. Holl, and B. Kiehling.
Water Research, Vol 15, No 8, p 1027-1034, August, 1981. 8 Fig, 4 Tab, 18 Ref.

Descriptors: *Anion exchange, *Bicarbonates, *Regeneration, Ion exchange, Resins, Drinking water, *Water treatment, Sulfates, Nitrates, Chlorides, Costs, Environmental effects.

Anion exchange resins in the bicarbonate form can reduce the concentration of neutral salts in water at a lower cost than cation exchange resins. Regeneration can be carried out with CO2 and CaCO3, which are inexpensive, environmentally safe substances. The wastewater generated contains only calcium salts in moderate concentrations, and total dissolved salinity is actually reduced because of the low solubility of carbonates of bivalent cations. Sulfate and nitrate ions are strongly preferred by all ion exchange resins, while affinity for chloride ions is less pronounced. Theoretical and experimental evaluations of exchange equilibria in regeneration with CO2 and CaCO3 found that only in incomplete conversion to the bicarbonate form is achieved. Method efficiency depends on the type of resin, the original counterion, and CO2 pressure. Thus, the resins only reduce sulfate, nitrate, and chloride concentrations. Since SO4(2-) and NO3(1-) are the most noxious anions in drinking water, anion exchange resins in the bicarbonate form are important. (Small-FRC)
W82-01484

INVESTIGATION OF VOLATILE ORGANICS REMOVAL,
American Water Works Service Co., Inc., Haddon Heights, NJ.
D. L. Kelleher, E. L. Stover, and M. Sullivan.
Journal of the New England Water Works Association, Vol 95, No 2, p 119-133, June, 1981. 8 Fig, 4 Tab, 1 Ref.

Descriptors: *Activated carbon, *Groundwater pollution, *Filtration, Adsorption, Water treatment, Iron, Manganese, Trichloroethane, Wells, Public health, Dedham, Massachusetts, Volatility, *Organic compounds, Westwood.

A comprehensive program to evaluate treatment techniques for removing volatile organic compounds from the wells of the Dedham Water Company (White Lodge Well fields in Westwood, Massachusetts) is described. The well field consisted of four conventional gravel-packed wells ranging from 70 to 76 feet deep with an estimated safe yield of 4.5 mgd. Significant levels of 1,1,1-trichloroethane (TCEA) were found in two of the wells. Twenty-five locations throughout the watershed were sampled, but no source was found for the contamination. Parallel air stripping and carbon adsorption studies were conducted to determine the feasibility of removing the organic compounds. Aeration and glauconite or greensand were evaluated for the removal of iron and manganese. The manganese greensand filter was capable of removing iron and manganese, and both packed-bed stripping columns and activated carbon columns were capable of removing TCEA. The most economical treatment alternative was air stripping and manganese greensand filtration. (Small-FRC)
W82-01490

RELATIONSHIP OF THE RAW WATER QUALITY TO MUTAGENS DETECTABLE BY THE AMES SALMONELLA/MICROSOME ASSAY IN A DRINKING-WATER SUPPLY,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 5A.
W82-01493

CHEMICAL CONTROL OF MUSSEL SETTLEMENT IN A COOLING WATER SYSTEM USING ACROLEIN,
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
J. W. Rijstenbil, and G. C. Van Galen.
Environmental Pollution, Series A, Vol 25, No 3, p 187-195, 1981. 7 Fig, 2 Tab, 10 Ref.

Descriptors: *Cooling water, *Fouling, *Mussels, Acrolein, Powerplants, Aquatic animals, Corrosion control, Estuaries, Toxicity, Industrial water, *Water treatment.

The influence of acrolein on young, newly settled mussels in a powerplant cooling water system is described. The aim of the control program is to expel most of the young mussels at a sublethal acrolein level, having a minimum discharge of the antifoulant into the receiving estuary. Young mussels were collected from bottom material and seaweeds of Lake Grevelingen in October of 1978. Toxicity tests were conducted in aquaria. Seawater was refreshed weekly and kept in circulation. Acrolein was added in concentrations of about 0.2, 0.4, 0.6 and 1.0 ppm. After exposure for periods of 2, 4, 6, 8, 12, 16, 20, or 24 hr, samples of mussels were examined. Two types of reaction were noted in mussels exposed to acrolein. Some had closed valves, and some mussels had become detached. There was no relationship between valve closure and time of exposure. It appeared that the mussels reacted immediately after exposure to acrolein by closing their valves. However, the percentage of mussels with closed valves increased with higher acrolein concentrations. In control experiments about 13% of the mussels became detached in the absence of acrolein in flowing seawater. Under the same circumstances a settlement reduction of 84% may be achieved in practice. A 24 hr application of 0.6 ppm acrolein followed by a 48 hr seawater flow was recommended. An environmental concentration below the toxicity threshold of 0.06 ppm acrolein will be achieved by a tenfold dilution on discharge. (Baker-FRC)
W82-01501

ORGANICS IN WATER - AN ENGINEERING CHALLENGE,
Stanford Univ., CA. Dept. of Environmental Engineering.
P. L. McCarty.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil

Engineers, Vol 106, No EE1, p 1-17, February, 1980. 4 Fig, 6 Tab, 16 Ref.

Descriptors: *Organic matter, *Drinking water, Reviews, *Water treatment, Water treatment facilities, Wastewater treatment, Industrial wastes, Domestic wastes, Organic wastes, Separation techniques, Organic compounds, Activated-carbon, Adsorption, Filtration, Adsorbents, Suspended solids, Coagulation, Oxidation, Volatility.

The nature of organic matter in water and its removal characteristics by possible treatment processes are reviewed. The purpose of the review is to indicate those processes which appear to have most promise in the near and far term for removing organic materials from drinking water supplies. Organic material in water may be either suspended or dissolved. That which is suspended is readily removed by normal chemical treatment and filtration. Dissolved materials may range from simple organic molecules to large and complex polymeric materials. Most of them arise from biological processing and decomposition of natural materials and are called humic materials. Processes for removal of organic materials include coagulation; oxidation, both chemical ad biological; membrane filtration; adsorption; liquid-liquid extraction; and volatilization. Activated-carbon adsorption has been shown in several studies to be the most effective single process for removing soluble organic materials in general. Mention is made of Water Factory 21, where treatment includes lime addition, air stripping, recarbonation, multi-media filtration, activated-carbon adsorption, and final chlorination. Reverse osmosis has also been employed at this plant since 1978. More than 100 different trace organics were identified in biologically treated wastewaters used as the water supply to Water Factory 21. In order to continue to protect the environment, the fate of organics stripped from water into the air must be carefully evaluated. Activated-carbon adsorption and biological growths associated with its use result in the production of organic chemicals that are different from those being removed. (Baker-FRC)
W82-01540

SMALL WATER SYSTEMS: ROLE OF TECHNOLOGY,
Municipal Environmental Research Lab., Cincinnati, OH. Drinking Water Research Div.
R. M. Clark.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No EE1, p 19-35, February, 1980. 7 Fig, 8 Tab, 13 Ref.

Descriptors: *Water supply, *Reviews, Water supply development, Water quality, *Water treatment facilities, Maintenance, Cost analysis, Water supply systems, Technology.

Some of the issues related to small water system problems are reviewed, with suggested feasible solutions. A prevailing characteristic of water supply technology is the effect of economics of scale. Small systems are a victim of their own size. Installation, operation, and maintenance of sophisticated control processes together with monitoring systems may result in substantial total and unit cost increases for small systems. Small systems also seem to have a larger share of quality problems. Some of the more common deficiencies include inadequate source protection, improper disinfection or control of disinfection or both, inadequate clarification or control of clarification and insufficient pressure in the distribution system. A commonly suggested solution for small system problems is that of regionalization in which a small community can join with other small communities or with a larger one to form a regional water supply. Technological solutions have also been investigated. The effectiveness of conventional coagulation and lime softening processes for the removal of certain metals has been studied. Package water treatment plants consisting of prefabricated and largely preassembled clarification and filtration units are commonly used in some sections of the US by small water systems. Various approaches to managing small systems are also being investigated and tried at various locations. (Baker-FRC)
W82-01542

CHRYSOTILE ASBESTOS FIBERS IN DRINKING WATER FROM ASBESTOS-CEMENT PIPE,
Wisconsin Univ. Madison. Dept. of Preventive Medicine.
For primary bibliographic entry see Field 5B.
W82-01592

5G. Water Quality Control

PUBLIC CONCERNS AND PLUARG: SELECTED FINDINGS AND DISCUSSION,
Toronto Univ. (Ontario). Dept. of Geography.
R. J. Mason.
Journal of Great Lakes Research, Vol 6, No 3, p 210-222, 1980. 1 Fig, 8 Tab, 24 Ref.

Descriptors: *Public participation, *Water pollution control, *Land use, Water policy, Planning, *International Joint Commission, *Great Lakes, Attitudes, Agriculture, Surveys, Pollution from Land Use Activities Reference Group.

The International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG) completed a program in which 17 public consultation panels (9 from 8 U.S. states and 8 from Canada) submitted reports detailing their views and recommendations on pollution control and land use. There were few significant differences on the national level in output from the 17 panels, which consisted of persons representing 19 categories, such as small business, students, women, farmers, and conservationists. There were some differences between the panels' consensus and the PLUARG report to the International Joint Commission on the importance of certain issues. The public consultation program was judged successful in terms of achieving its objectives and in terms of participant satisfaction. (Cassar-FRC)
W82-01137

MODELLING EFFECTS OF REMEDIAL PROGRAMS TO AID GREAT LAKES ENVIRONMENTAL MANAGEMENT,
Canada Centre for Inland Waters, Burlington (Ontario).
M. G. Johnson, J. C. Comeau, T. M. Heidtke, W. C. Sonzogni, and B. W. Stahlbaum.
Journal of Great Lakes Research, Vol 6, No 1, p 8-21, 1980. 4 Fig, 8 Tab, 38 Ref.

Descriptors: *Phosphorus, *Great Lakes, *Water pollution control, Lakes, Lake Erie, Lake Huron, Lake Ontario, Model studies, Nonpoint pollution sources, International Joint Commission, Water pollution sources, Agriculture, Water quality control, Urban runoff, Fertilizers, Effluent standards, Storm water.

PLUARG (the International Joint Commission's Pollution from Land Use Activities Reference Group) used computer simulation to determine which remedial programs were most economical, practical, and effective for reaching target lake loads of phosphorus for Lakes Erie, Ontario, and southern Huron. The process relied on a large and diverse information base on point and nonpoint pollution sources in the Great Lakes basin, including sub-basin unit area pollution loads (classified by land use and land form), per capita municipal pollutant inputs, river transmission factors, and remedial program effectiveness. The remedial measures included three levels of treatment for rural areas with reductions in total P load of 5-10%, 25%, and 40% (costs: minimal, $600 per sq km, and $2700 per sq km, respectively), and two treatment levels for urban areas: vacuum street cleaning and runoff storage and treatment by sedimentation. For municipal treatment plants three levels of residual P concentrations were considered, 1.0 ppm, 0.5 ppm, and 0.3 ppm, at costs of $2350, $3340, and $9370 per 1000 persons served. For example, the least cost strategy for Lake Ontario's 7000 ton P reduction was as follows: rural management, lowest level; effluent from treatment plants, 0.5 ppm; and urban nonpoint treatment, lower level. (Cassar-FRC)
W82-01146

STUDIES FOR ABATEMENT OF POLLUTION FROM COMBINED SEWER OVERFLOWS IN CANADA,
MacLaren (James F.) Ltd., Toronto (Ontario). Water Resources Div.
P. E. Wisner, W. G. Clarke, and A F. Roake.
Journal of Hydrology, Vol 51, No 1-4, p 329-338, May, 1981. 4 Fig, 4 Tab, 5 Ref.

Descriptors: *Model studies, *Combined sewers, Simulation, Runoff, *Urban runoff, Biological oxygen demand, Oxygen demand, Suspended solids, Water pollution sources, Municipal wastes, Municipal wastewater, Sewers, Water quality, *Combined sewer overflows, Pollution abatement studies, *Canada.

The use of urban runoff models to study water quality problems in Winnipeg, Edmonton, Hamilton, St. Thomas, Sarnia and other Canadian cities is described. Different simulation models were used at different stages of a project. Planning models were used for an overall assessment of the urban runoff problem and for preliminary estimates of the cost effectiveness of different abatement procedures. Design/analysis models are oriented towards the detailed simulation of storm events, and can be used for accurate predictions of flows and concentrations at any point in the urban system and the receiving waters as well. The lumped quality model offers a preliminary step toward simplified quality modelling. Work with this model may be useful in other drainage environments as well, due to its great flexibility. The interfacing of simulation models has been used to obtain a general approach to the analysis of urban water-quality problems. In the Winnipeg study, the first stages of storm runoff were predicted to contain greater pollutant concentrations in the combined sewage than those which would be found during dry-weather flow due to the scour of solids deposited in the trunk combined sewers during dry weather. The study concluded that separation was not the most effective abatement method for the existing combined system. Instead a system of total management involving storage, overflow treatment and nonstructural controls such as sewer flushing is both more effective and more economic. Studies in Edmonton illustrate the use of simulation techniques to assess overflow pollution in the context of all sources of pollutants affecting North Saskatchewan River quality. As a result of these studies, various combinations of storage, flow equalization, upgraded central treatment and source control are being investigated and evaluated in terms of simulated water quality and economics. (Baker-FRC)
W82-01200

URBAN RUNOFF AND COMBINED SEWER OVERFLOW,
Syearns and Wheeler, Cazenovia, NY.
For primary bibliographic entry see Field 5B.
W82-01254

COAL AND COAL MINE DRAINAGE,
Tennessee Valley Authority, Chattanooga.
H. Olem.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 814-824, June, 1981. 1 Tab, 158 Ref.

Descriptors: *Coal mining, *Mine wastes, *Water pollution effects, Water quality, Acid mine drainage, *Water pollution control, Regulations, Water pollution sources, Wastewater treatment, Path of pollutants, Aquatic life, Industrial wastewater.

The recent literature on the effects of the coal industry on water quality lists several government reports on this subject as well as regulatory developments since passage of 1977 legislation. About 15 abstract collections, bibliographies, and reviews on coal and the environment have been published in the last year. Formation of mine drainage is the

subject of work relating to bacterial and chemical actions on rocks and minerals. About 60 authors wrote papers on the impact of mine drainage on water quality in coal fields in Europe and the U.S. In one case, acidity was increased 580% by renewed mining activity. Mathematical models are featured in many papers. The differences between eastern and western U.S. coal mining are highlighted; mining activities in the west do not produce as much acidic drainage as in the east. However, western rivers are more susceptible to increased sedimentation and salt loadings. Groundwater quality was evaluated in mining areas throughout the U.S. There were severe effects in some locations in the northern Great Plains and lesser effects in eastern Ohio, Indiana, and Illinois. Several publications discuss the impact of mining on benthic invertebrates, zooplankton, and fish. Treatment methods for mine drainage water include lagoons for neutralization and iron removal, rotating disks for biological oxidation of ferrous iron, and lime neutralization with further treatment to enhance the municipal potable water supply, and sedimentation ponds. Prevention and control of mine slow-release anionic detergents on surface mines and coal refuse piles, recycling effluents, use of crushed limestone, and reclamation projects for surface-mined land. The effects of coal cleaning and coal transportation and storage on water quality are discussed. (Cassar-FRC)
W82-01261

EUTROPHICATION,
Colorado Univ. at Boulder.
For primary bibliographic entry see Field 2H.
W82-01271

DISSOLVED OXYGEN IN STREAMS AND RESERVOIRS,
Tennessee Valley Authority, Chattanooga.
C. E. Bohac.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 916-921, June, 1981. 65 Ref.

Descriptors: *Dissolved oxygen, *Literature review, Reviews, *Streams, Rivers, *Reservoirs, Standards, Surface runoff, Runoff, Water quality, Model studies, Oxygen demand, Oxygen transfer.

Current research dealing with dissolved oxygen in streams and reservoirs is cited in this review article. In reviewing standards which had been established for streams, it was concluded that the standards had been developed without enough information regarding their practical implementation. The Urban Runoff Pollution Control Program was studied with particular emphasis on receiving water quality models of three types: simplified or desktop models for preliminary planning; detailed models for planning and design; and operational models for supervisory control. Water quality was investigated in lakes and streams, with particular emphasis on winter oxygen depletion rates, severe hypolimnetic oxygen depletion in Canyon Lake, specific reference to two Yukon rivers where severe dissolved oxygen depressions during winter months were reported, and various hypolimnetic oxygen parameters. A reaction chamber was developed to study interactions of sediments or newly flooded soils with an overlying water column. In the area of improving water quality, the addition of hydrated lime to a lake, the treatment of water with alum resulting in a six-fold decrease in soluble phosphorus and a 17-fold decrease in orthophosphate, and aeration of a model lake system were studied. Water quality models were engineered which were used to determine wasteload allocations, to investigate alternative water quality policies in relation to waste discharges, to describe vertical and horizontal variability of a water body, to estimate economic benefit for water pollution control programs, and to predict the impact of storm loads on phosphorus, fecal coliforms, and dissolved oxygen. Oxygen demand was studied both from the general point of view and with emphasis on the effect of photosynthesis on oxygen demand. Oxygen transfer was also investigated. (Baker-FRC)
W82-01272

ANALYSIS OF NATIONAL WATER POLLUTION CONTROL POLICIES 1. A NATIONAL NETWORK MODEL,
Resources for the Future, Inc., Washington, DC.
For primary bibliographic entry see Field 6A.
W82-01292

ECONOMICS,
Clemson Univ., SC.
J. C. Hite.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 615-617, June, 1981. 20 Ref.

Descriptors: *Economic aspects, *Water pollution control, *Costs, *Reviews, Agriculture, Erosion control, Water quality.

The recent decline in number of papers concerning economics of water quality can be attributed to the perception that water scarcity is a more important consideration than environmental degradation. Several theoretical questions were addressed: the balance of resource protection vs. industrial development, effluent charges and market structure, an optimal pollution control program under conditions of imperfect information, and compensating payments in salary externality problems. Agricultural economists produced a variety of papers on tradeoffs between agricultural production costs and sediment damage, research needed on erosion and sedimentation problems, the effect of tenure arrangements vs. regional factors on erosion levels, converting noncropland to cropland in the Mississippi delta, and reaction of farmers to public programs on soil conservation. A series of articles investigated how transferable discharge rights might be used for phosphorus pollution control in Lake Michigan. A study of annualized costs of water pollution abatement by industry and by family income class showed that low-income families would bear a disproportionately high portion of pollution control costs. Real spending for all types of pollution abatement increased by 5% in 1978, and for water pollution abatement, by 9%. Reasons for economists' objections to technology-based effluent standards were stated in a definitive work. (Cassar-FRC)
W82-01304

THE WORKINGS OF THE CONTROL OF POLLUTION ACT IN TIDAL WATERS: A VIEW OF THE MINISTRY OF AGRICULTURE, FISHERIES AND FOOD,
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Lab.
For primary bibliographic entry see Field 6E.
W82-01383

THOUGHTS ON THE NEED TO CONTROL DISCHARGES TO ESTUARIAL AND COASTAL WATERS,
Department of the Environment, London (England).
For primary bibliographic entry see Field 6E.
W82-01384

RURAL SANITATION IN DEVELOPING COUNTRIES,
Hawksley (Watson), High Wycombe (England).
For primary bibliographic entry see Field 5D.
W82-01392

USE OF THE CONTINGENCY FUND AT STRINGFELLOW HAZARDOUS WASTE DISPOSAL SITE,
Coast Guard, Hamilton AFB, CA. Pacific Strike Team.
G. A. Reiter, and R. M. Mandel.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980 Washington, DC, Environmental Protection Agency Report (1980). p 21-24, 2 Tab, 5 Ref.

Descriptors: *Waste disposal, *Land disposal, Flooding, *Water pollution control, Costs, Federal jurisdiction, Wastewater treatment, Berms, Planning, Water pollution prevention, State jurisdiction, *Stringfellow Quarry, *California.

Because of the repeated flooding and overflow of pollutants from the Stringfellow Quarry waste disposal site, and the exhaustion of local abatement funds, the California State Water Resources Control Board (RWQCB) petitioned the EPA for use of Section 311(k) funds of the Clean Water Act. Use of the funds was authorized and a number of actions were taken in March 1980. Three and a half million gallons of liquid wastes were removed and treated at the Palo Verde treatment site. The berms were strengthened to prevent collapse, and a pump was installed to remove accumulating liquids in pond No. 1. Pumping and aeration were continued by the RWQCB after the Federal activities ceased. The value of a coordinated response was demonstrated in dealing with hazardous waste site discharges. Effective planning from the time of notification to termination is possible, although the estimates of the immediacy of the threat and appropriate mitigation measures may differ among the agencies involved. (Brambley-SRC)
W82-01416

PRELIMINARY RISK EVALUATION FOR SUSPECTED HAZARDOUS WASTE DISPOSAL SITES IN CONNECTICUT,
TRC Environmental Consultants, Inc., Wethersfield, CT.
D. Unites, M. Possidento, and J. Housman.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980. Washington, DC, Environmental Protection Agency Report (1980). p 25-29, 3 Fig, 1 Tab, 3 Ref.

Descriptors: *Waste disposal, *Land disposal, *Hazardous materials, *Toxicity, Evaluation, Priorities, Water supply, *Water pollution prevention, Pollutants, Groundwater pollution, Polychlorinated biphenyls, Pesticides, Fishkill, Runoff, *Connecticut.

Connecticut Public Act No. 79-605 mandates the commissioner of environmental protection to inventory toxic or hazardous waste disposal sites and the types and amounts of wastes disposed therein. A four-phase program has been developed, which is in progress. The first phase resulted in the identifying of 3072 potentially hazardous sites, with 28 added later. The second phase resulted in giving priority for site investigation to those sites in towns with the largest populations using private wells, with low priority given to towns with public water supplies. The third phase is a preliminary evaluation using a flow chart which identifies seven critical conditions requiring immediate action. These are: improperly disposed liquid polychlorinated biphenyls; asbestos that can become airborne; improperly disposed pesticides; disposal within 200 ft of a drinking water supply; possible fire or explosion; fish kills; and discharge of hazardous materials to storm sewers or surface water. The final phase is a more detailed analysis based on a numerical scoring system. Approximately 30% by area of the state has been reviewed, with 10 sites referred for further study or enforcement action, and 20 notices of violation for minor problems have been issued. (Brambley-SRC)
W82-01417

RATING THE HAZARD POTENTIAL OF WASTE DISPOSAL FACILITIES,
JRB Associates, Inc., McLean, VA.
C. Kufs, D. Twedell, S. Paige, R. Wetzel, and P. Spooner.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC Environmental Protection Agency Report (1980). p 30-41, 4 Fig, 4 Tab, 10 Ref.

Descriptors: *Waste disposal, *Land disposal, *Hazardous materials, Waste management, Waste characteristics, Evaluation, Path of pollutants, Water quality control, Groundwater, Surface water, Environmental protection, Pollution rating systems.

A method has been developed for use by hazardous waste coordinators in the evaluation of the hazards posed by land disposal facilities to popula-

tions, ground and surface waters, and critical environments. The method has three elements: the rating factor system which rates the general hazard potential of the site; the additional points system which modifies the rating based on site-specific factors; and the scoring system which interprets the ratings in meaningful terms. There are 31 factors in the rating factor system, in four categories: receptors, pathways, waste characteristics, and waste management practices. By assigning a point score to each factor a numeric value may be obtained for each category, and when summed, for the overall score. Sites may be ranked for hazard by relative or absolute overall score, or by single category scores. The single category scores are appropriate when significant data are lacking about a particular site. The rating forms are presented, and scores are given for actual sites for sample site rankings. (Brambley-SRC)
W82-01418

THE NATIONAL ASSESSMENT OF THE GROUND-WATER CONTAMINATION POTENTIAL OF WASTEWATER IMPOUNDMENTS,
Environmental Protection Agency, Washington, DC.
L. R. Silka.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC. Environmental Protection Agency Report (1980). p 45-48, 3 Tab, 5 Ref.

Descriptors: *Waste disposal, *Land disposal, *Groundwater pollution, *Wastewater lagoons, *Industrial wastes, Linings, Monitoring, Hazardous materials, Water supply, Groundwater movement, Municipal wastes, Farm wastes, Mine wastes, Brines, Surveys.

The EPA assisted the states in conducting the Surface Impoundment Assessment with the aim of determining the number, location and potential effects of these sites on groundwater and of improving the information on impoundments and groundwater protection. A total of 77,678 sites were identified, 10,819 of which the were industrial sites, which were given highest priority in subsequent analyses. The industrial waste sites are estimated to cover about 430,000 acres and receive 50 billion gallons per day of influent. Fewer than 30% are lined, and more than 95% have no regular monitoring. About half the sites contain waste which may have potentially hazardous constituents. Thirty percent overlie usable aquifers and are underlain by zones which allow free movement of escaping wastes. About one third of these sites are within one mile of a water supply well which would be in the path of contaminated water flowing from the site. Similar lack of proper siting, design and monitoring is indicated in the information obtained for municipal, agricultural, mining, and oil and gas brine waste liquids sites. The industrial and municipal sites pose the greatest threat to drinking water resources, while the remainder threaten agricultural groundwater resources. The minimal monitoring of the waste sites results in discovery of contamination only after gross, noticeable environmental changes occur. (Brambley-SRC)
W82-01419

EVALUATION OF HYDROGEOLOGIC CONDITIONS,
Geraghty and Miller, Inc., Annapolis, MD.
J. J. Geraghty.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC. Environmental Protection Agency Report, (1980). p 49-52, 8 Ref.

Descriptors: *Hydrologic data, *Land disposal, *Waste disposal, *Hazardous materials, *Groundwater pollution, Evaluation, Monitoring, Water quality, Wells, Geophysics, Seismology, Groundwater movement, Plumes.

Current hazardous waste regulations contain requirements for monitoring the groundwater around disposal sites, and for investigating subsurface conditions if the groundwater has become contaminated. Some of the subsurface exploratory procedures used prior to monitoring or remedial action are described. The objectives of the exploration may differ, but in each case the geology, hydrology and the water quality will be investigated. Most investigations will require the drilling of wells, but preliminary studies can minimize their number and maximize the information they yield. This information may be obtained from geological records, site observations, past drilling records, and operational wells in the area. Geophysical surveys using seismic or electrical resistivity methods can provide information on the geology and hydrology and are most useful when some prior knowledge exists. Magnetometer surveys and temperature studies may also be useful. Hydrologic information is best obtained from test wells which can be logged, pumped and sampled, and they will give additional geologic information. Several wells may be necessary to determine the movement of water in an aquifer, and the contaminant plume dimensions. The information collected can then be used to predict possible changes in directions and rates of plume movement due to natural variations or human invervention. (Brambley-SRC)
W82-01420

PRACTICAL ASPECTS OF GROUND WATER MONITORING AT EXISTING DISPOSAL SITES,
Law Engineering Testing Co., Atlanta, GA.
J. R. Absalon, and R. C. Starr.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report, (1980). p 53-58, 4 Fig, 4 Ref.

Descriptors: *Waste disposal, *Land disposal, *Monitoring, *Groundwater pollution, *Wells, Landfills, Aquifers, Waste characteristics, Sampling, Protection, Landfills, Wastewater lagoons, Water pollution control, Resource Conservation and Recovery Act.

The Resource Conservation and Recovery Act requires monitoring of ground water at surface impoundments, landfills and land treatment facilities to determine the impact of waste disposal on the quality of the water in the uppermost aquifer beneath the site. The site geology and waste facility characteristics are determined from available information, records, and field investigations. These investigations will aid in the most effective placement of monitoring wells. Monitoring wells should be installed using methods, equipment, and materials that minimize changes in the aquifer, introduction of foreign materials, and cross contamination betwen wells and aquifers. Aquifer changes can be prevented by sealing between aquifers and using appropriate drilling techniques. Foreign materials which may contaminate ground water include water and drilling muds from the boring process, contaminants adhering to the drilling equipment, and the well material itself, especially when PVC is used as the casing. Wells should be pumped or bailed before monitoring samples are taken, so as to obtain water unaffected by the drilling process. Samples must be treated or preserved to maintain their integrity before testing. In dealing with sites containing hazardous wastes, workers and the public must be protected from exposure, by the appropriate equipment and information. (Brambley-SRC)
W82-01421

SITE ASSESSMENT: IMPROVING CONFIDENCE LEVELS WITH SURFACE REMOTE SENSING,
Technos Inc., Miami, Florida.
R. C. Benson, and R. A. Glaccum.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 59-65, 9 Fig, 3 Ref.

Descriptors: *Waste disposal, *Land disposal, *Hazardous materials, *Groundwater contamination, Surveys, Groundwater movement, Leachates, *Remote sensing, Radar, Magnetic studies, Water pollution control, Plumes, Geologic formations, Subsurface mapping.

Remote sensing of hazardous wastes sites allows a great deal of information to be gained about the geology of the site, materials in the site, and movement of leachate from the site. The four most useful methods available are found penetrating radar, electromagnetics, magnetometry, and metal detection, frequently used in combination with each other. Electromagnetic conductivity data can be used to locate geological details such as fractures, paleosinks, and pockets through which contaminants may move, and also contaminant plumes. Radar can be used to locate and estimate the size of trenches. Metal detectors are used to locate metal objects such as drums, while the ferrous or non-ferrous nature of the metal can be determined by magnetometry. Continuously measuring instruments have been designed to produce a continuous record from a pass over a site. By running closely spaced parallel survey lines information can be mapped over the entire site area, quickly and inexpensively in comparison with direct sampling methods. (Brambley-SRC)
W82-01422

MAPPING CONTAMINATED SOIL PLUMES BY KRIGING,
Resources Management Associates, Lafayette, CA.
S. F. Moore, and D. B. McLaughlin.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report, (1980). p 66-70, 5 Fig, 1 Tab, 8 Ref.

Descriptors: *Hazardous materials, *Plumes, *Subsurface mapping, *Soil contamination, Spatial distribution, Mathematical models, Groundwater pollution, Groundwater movement, Monitoring.

Data on the distribution of hazardous waste contaminants in soils are inherently uncertain and incomplete. An effective mapping method was developed to study the contaminant plumes in the soil at the Hanford, Washington, nuclear waste site. Statistical formulation of the problem led to the choice of kriging as an appropriate estimation procedure to facilitate computer mapping. Kriging is based on assumptions about the variation in spatial differences of a variable, rather than absolute values. A kriging model partitions observed variability between a local drift function and a random process which has a spatial correlation structure represented by the variogram. Solution of the contaminant mapping problem consists of: setting up a grid of points at which contaminant values are to be estimated; forming the 'kriging equations' at each grid point and solving for the weighting factors; computing the estimate and its variance at each grid point; and drawing in smooth contour lines delineating the contaminant distribution throughout the area of interest. The method was used to determine ruthenium-106 movement at a tank farm. Some locations of higher values are identified; these represent priority candidate sites for additional sampling wells. (Brambley-SRC)
W82-01423

GEOLOGICAL STUDIES OF INDUSTRIALLY-RELATED CONTAMINATION: SOIL AND GROUND WATER INVESTIGATIONS,
Metcalf and Eddy, Inc., Boston, MA.
For primary bibliographic entry see Field 5B.
W82-01425

REMEDIAL OPTIONS FOR GROUND WATER PROTECTION AT ABANDONED SOLID WASTE DISPOSAL FACILITIES,
Penn Environmental Consultants, Inc., Pittsburgh, PA.
D. Threlfall, and N. J. Dowiak.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC. Environmental Protection Agency Report, (1980). p 131-134, 2 Tab, 5 Ref.

Descriptors: *Waste disposal, *Land disposal, *Groundwater pollution, *Water quality control, Infiltration, Leachates, Drainage, Cost analysis, Soil compaction, Impervious soils.

Remedial measures to protect ground water will depend on the subsurface conditions and the characteristics of the waste. Limited remedial measures such as site covering or controlling the flow of surface water may be sufficient if there are geologic barriers to leachate migration, little or no ground water is affected, or the waste has a low-hazard potential. Extensive measures such as leachate collection systems, ground water collection systems, slurry walls or covers may be required if there are no geologic barriers, usable ground water is affected, or if the waste is significantly hazardous. An evaluation was performed at an abandoned strip mine pit, 10 acres in area and 60 ft deep, which had been used for the disposal of neutralized acid waste sludges. Significant infiltration was occurring from the surface into the ground water which flowed into good quality surface water. A drainage collection network was designed to intercept leachate as it emerged downstream from the site, and it was conveyed to a water treatment plant. An impermeable cover was necessary to prevent leachate formation. Bentonite soil additives, PVC membranes and compacted local soil were considered. Compacted local soil was the least expensive option, and, once the sludge had dried out, sufficient compaction was possible to obtain the necessary impermeability. This approach combined economic and technical feasibility, but leachate collection and treatment must be continued until the cover is in place. (Brambley-SRC)
W82-01426

TOP-SEALING TO MINIMIZE LEACHATE GENERATION, CASE STUDY OF THE WINDHAM, CONNECTICUT, LANDFILL,
SMC-MARTIN, King of Prussia, PA.
G. H. Emrich, and W. W. Beck, Jr.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report, (1980). p 135-140, 6 Fig, 2 Ref.

Descriptors: *Landfills, *Groundwater pollution, *Water pollution control, *Leachates, Municipal wastes, Grading, Monitoring, Lysimeters, Water quality, Plumes, Water pollution prevention, Case studies, *Windham, Connecticut.

The Windham, Connecticut, Landfill was selected to demonstrate remedial actions to abate or minimize pollution from closed landfills. The system of remedial actions used at this site included regrading, covering at a minimum depth of 15 cm with local sand and gravel and a minimum of 10 cm of fine-grained sand washings, the application of a 20-mil PVC cover and a final 46-cm vegetated cover. A monitoring system has been installed consisting of suction lysimeters and pan lysimeters to determine the movement of moisture through the refuse, a ground water monitoring system consisting of wells to determine fluctuations in the water table as well as the rate and movement of leachate in the ground water, and surface water monitoring system consisting of staff gages in nearby ponds. Monitoring of the landfills has continued for several years established complete baseline data, and will continue for two years following the installation of the remedial action alternatives to determine their effectiveness. In the seven months since the implementation of the remedial action, the groundwater quality has improved and the leachate plume has retreated to the landfill. (Brambley-SRC)
W82-01427

REMEDIAL TECHNIQUE OF CONTROLLING AND TREATING LOW VOLUME LEACHATE DISCHARGE,
Nassaux-Hemsley, Inc., Chambersburg, PA.
W. T. Hemsley, and W. C. Koster.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980. Washington, DC, Environmental Protection Agency Report (1980). p 141-146, 3 Fig, 6 Tab.

Descriptors: *Landfills, *Leachates, *Water pollution control, *Waste disposal, *Wastewater treatment, Wells, Drains, Heavy metals, Coagulation, Carbon adsorption, Chlorination, Sludge disposal, Water quality standards, Suspended solids, Pollution load, *Franklin County, Pennsylvania.

The remedial measures installed to control leachate at a landfill after closure are described. The site has an area of 15 acres on a steeply bedded shale in Franklin County, Pennsylvania. The newer part of the site is graded to provide good surface drainage but was the source of the leachate to be controlled. Piezometers were used to produce a groundwater map, and determine infiltration and horizontal permeability. Based on these figures, it was recommended that collection wells, with connections to a collection drain, be installed around the perimeter, and that the leachate be treated chemically before discharge. Four collection wells were dug, with a total leachate yield of 8.15 gpm. The leachate exceeded the state discharge requirements in suspended solids, BOD, ammonia-nitrogen, iron, lead, mercury and copper. Laboratory tests indicated that alum would be the most effective coagulant, but that activated carbon filtration was necessary to remove metals. The final leachate treatment is chlorination. The sludge is taken to an approved landfill, and the discharge meets the Pennsylvania requirements. (Brambley-SRC)
W82-01428

SURFACE WATER MANAGEMENT AT HAZARDOUS WASTE SITES,
Dames and Moore, Atlanta, GA.
T. J. Doyle.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 152-159, 7 Fig, 1 Tab, 4 Ref.

Descriptors: *Land disposal, *Waste disposal, *Water pollution prevention, *Hazardous materials, *Regulations, Environmental protection, Runoff, Floods, Flood control, Spillways, Water pollution sources, Surface water management.

The regulations applicable to hazardous waste sites and water resource protection are reviewed. A site may not be located in regulatory floodways, coastal high hazard areas, the 500-yr floodplan, or wetlands. In some cases permission may be granted for a site in an environmentally sensitive area, if it is designed, constructed, operated and maintained so that it would not be inundated by a specific flood or storm event. In order to protect surface waters from contamination it must be shown that runoff will not enter the facility, or diversion structures must be provided. These may include interceptor ditches, underflow systems, or diversion ditches, pipelines and tunnels. The use of diversion facilities can be reduced by installing floodwater detention basins, to reduce the peak discharge from any storm. Liquid or semi-liquid storage impoundments must have an adequate freeboard or an emergency spillway, sufficient to withstand the Probable Maximum Flood. Hazardous waste facilities must operate in compliance with the Clean Water Act in respect to point and non-point pollutant sources. They must have a closure plan which will be implemented for at least 30 yrs from the date of closure, to prevent soil erosion and exposure of hazardous waste to the environment. (Brambley-SRC)
W82-01429

BENCH SCALE ASSESSMENT OF TECHNOLOGIES FOR CONTAMINATED GROUND WATER TREATMENT,
Touhill, Shuckrow and Associates, Inc., Pittsburgh, PA.
A. J. Shuckrow, A. P. Pajak, J. W. Osheka, and S. C. James.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report, (1980). p 184-191, 9 Fig, 2 Tab, 3 Ref.

Descriptors: *Groundwater pollution, *Water treatment, *Waste dumps, *Pollutants, *Organic compounds, Biological treatment, Activitated carbon, Adsorption, Chemical coagulation, Resins, Membrane processes, Stripping, Continuous flow.

Contaminated groundwater is a consequence of uncontrolled industrial waste sites which may need treatment to remove the contaminants. An initial study reduced 18 potential technologies for removing 500 compounds in 12 classes to six - biological treatment, chemical coagulation, carbon adsorption, membrane processes, resin adsorption, and stripping. It was recognized that no single treatment would be effective so five processtrains were designed: biological/carbon sorption, carbon/biological, biophysical, membrane/biological, stripping/carbon sorption. Bench scale studies were conducted with an actual contaminated ground water. It contained over 70 organic pollutants, primarily priority pollutants, but heavy metals were not believed to be a problem. Carbon adsorption was most effective in removing organic pollutants, with resin sorption and air stripping somewhat less effective, although significant residual total organic carbon (TOC) remained in all samples. Continuous flow studies were then conducted using stream stripping and granular activated carbon. Small scale biological reactors were also tested, first to acclimate the organisms to the contaminated water, then to test their effectiveness in removing TOC. Up to 60-80% TOC removal was achieved. These studies will continue; biophysical treatment and pretreatment methods will be studied. (Brambley-SRC)
W82-01433

EVALUATION OF REMEDIAL TREATMENT, DETOXIFICATION AND STABILIZATION ALTERNATIVES,
Anderson-Nichols and Co., Inc., Boston, MA
For primary bibliographic entry see Field 5D.
W82-01434

PRELIMINARY DESIGN AND COST ESTIMATES FOR REMEDIAL ACTIONS AT HAZARDOUS WASTE DISPOSAL SITES,
JRB Associates, Inc., McLean, VA. Waste Management and Resource Recovery Div.
S. F. Paige, C. H. Morgan, H. C. Bryson, G. E. Hunt, and P. J. Rogoshewski.
In: EPA National Conference on Management of Uncontrolled Hazardous Wastes, October 15-17, 1980, Washington, DC, Environmental Protection Agency Report (1980). p 202-207, 2 Fig, 2 Tab, 6 Ref.

Descriptors: *Waste disposal, *Water pollution control, *Groundwater pollution, *Hazardous materials, *Design criteria, Costs, Soil contamination, Land disposal, Waste characteristics, Capital costs, Maintenance costs, Financing, Budgeting.

Uncontrolled hazardous waste sites can cause contamination of the surface, groundwater, air, sewer and water lines, soils and sediments. Any remedial action must first consider the contaminated areas and then prepare a design plan and estimate its cost. The preliminary design will consider the remedial activities, the necessary equipment, wastes or residues that may be generated and their final disposition, land requirements, site characteristics, the dimensions of the techniques to be performed, and the time needed for each activity. The preliminary design information is used to estimate overall costs, which comprise immediate and longterm costs. The immediate costs are the capital, labor and other costs associated with the installation of the remedial action techniques. The long-term costs are those required for maintenance, monitoring and general operation of the equipment, and may be required in perpetuity. This very long-term financial requirement necessitates determinations of site costs, inflation, discount rate, the size of contingency funds, and the means of generating these funds. (Brambley-SRC)
W82-01435

IDENTIFICATION AND RECLAMATION OF CHROMIUM SLUDGE DISPOSAL SITES,
Maryland Office of Environmental Programs, Annapolis.
For primary bibliographic entry see Field 5E.
W82-01437

NEW OPPORTUNITIES FOR IN-PLANT REDUCTION OF POLLUTANTS THROUGH PROCESS CHANGES,
International Paper Co., Tuxedo Park, NY.
J. J. Renard, R. B. Phillips, H. Jameel, and A. W. Rudie.
Tappi, Vol 64, No 8, p 51-54, August, 1981. 1 Fig, 3 Tab, 14 Ref.

Descriptors: *Pulp and paper industry, *Pollution load, *Kraft mills, Water pollution prevention, *Water pollution control, Oxygenation, Process control, Chlorine dioxide, Anthraquinone, Costs.

The most significant effective option for reducing pollution from a beached kraft mill was oxygen delignification of the unbleached pulp. Application of oxygen in the caustic extraction stage was least effective. However, both oxygen-based options reduced product costs. The other two processes evaluated, cooking to lower kappa numbers with anthraquinone catalyst and use of chlorine dioxide in the first bleaching stage with hypochlorite in the extraction stage, were more costly. The four methods reduced pollution loads between 20% and 60%. For a new mill, oxygen delignification requires a sizable capital investment and is generally not recommended over the less complicated process using oxygen in the extraction stage. For an existing mill the two oxygen-based options are preferred. (Cassar-FRC)
W82-01559

REMEDIAL ACTION CONTROLS GROUNDWATER CONTAMINATION AT A PAPER MILL SLUDGE DISPOSAL SITE,
Soil Testing Services of Wisconsin, Inc., Green Bay.
J. A. Senger.
Tappi, Vol 64, No 8, p 41-43, August, 1981. 5 Fig.

Descriptors: *Pulp and paper industry, *Leachates, *Landfills, Industrial wastes, Sludge disposal, Water quality, Groundwater, *Water pollution prevention, Water pollution control.

Leachate from an abandoned primary sludge landfill at a paper mill was controlled by taking advantage of existing hydrogeological conditions. Three problems contributed to the seepage: the site received discharge from a city storm sewer pipe, sandy soils directly underneath the sludge fill contained groundwater, and pore water was released during sludge consolidation. Corrective measures included diverting the sewer pipe away from the landfill; construction of a retaining dike, a clay cutoff wall downgradient, a collection pipe and two 20,000 gal storage tanks (from which leachage is routed to the treatment plant; and deposition of 2 feet of sand and 6 inches of topsoil as a final cover, which was then seeded and planted with grass and shrubs. These measures have greatly improved groundwater quality. Currently sludge is disposed of in two cells lined with clay. A sand blanket confines the sludge and allows leachage to drain into the cell for collection and transport to the treatment plant. (Cassar-FRC)
W82-01582

SITING AND DESIGN OF TAILINGS IMPOUNDMENTS,
Klohn Leonoff Inc., Denver, CO.
For primary bibliographic entry see Field 8A.
W82-01588

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

AN EXAMPLE OF THE APPLICATION OF STATISTICAL TECHNIQUES TO PREDICT LAKE LEVEL ELEVATIONS,
Department of the Environment, Edmonton. Div. of Design and Construction.
S. D. Koppula.
Canadian Journal of Civil Engineering, Vol 8, No 2, p 114-121, June, 1981. 3 Fig, 7 Tab, 10 Ref.

Descriptors: *Predictions, *Water levels, *Lakes, *Mathematical models, Statistical methods, Land use, Flood control, Storm water, Water level fluctuations, Management planning, Statistical models.

Advance knowledge of the magnitude of the temporal variations of future lake levels can assist the development of optimum stormwater management strategies relating to flood control, land use measures, and budgeting. Knowledge of future lake levels is very important, since these lake levels will determine the type of objectives and strategies which management must develop. The use of two statistical methods to examine available data on monthly lake water levels is reported. The Box-Jenkins forecasting technique consists of fitting a mixed autoregressive integrated moving average (ARIMA) model to the data and extracting conditional expectations. Harmonic analysis involves fitting a sine-cosine curve which possessed the property of regular undulating oscillations to data when the cyclical movements of a time series composed of seasonal variations, cyclic fluctuations, and random variations cover the same time span. These two statistical models are used to predict future lake levels in Lesser Slave Lake in Alberta, Canada, using monthly water level data, and these predictions are compared with actual observations. The predictions made by the Box-Jenkins model were found to be closer to the recorded observations than those made by harmonic analysis. Combination of the results from the two independent models to develop a composite forecast gave results which were slightly better than those given by either of the independent models alone. The composite model permitted consideration of the inherent cycles of periodicity greater than 12 months, resulting in improved forecasts. (Carroll-FRC)
W82-01111

WATER MULTIPLIERS--REGIONAL IMPACT ANALYSIS,
Hawaii Univ., Honolulu. Dept. of Agricultural and Resource Economics.
C. T. K. Ching.
Water Resources Bulletin, Vol 17, No 3, p 454-457, June, 1981. 3 Tab, 10 Ref.

Descriptors: *Regional planning, *Water demand, *Input-output analysis, Planning, Water resources development, Economic aspects, Moel studies, Water multipliers, *Nevada, Leontief models, Employment, Income.

The Leontief input/output model is typical of methods for assessing the impacts of changes in regional economy produced by growth and/or decline. Sales, income or value added, and employment are the economic variables commonly used. This paper suggests that resource multipliers be added to the analysis. Direct water coefficients (acre-feet per $1000) and water multipliers for Humboldt and Lander Counties, Nevada, are devised for each of 22 sectors of the input/output model. Direct water coefficients vary from 0.001 for Communication to 12.8240 for Alfalfa and Other Hay. Water multipliers vary from 154.5250 for the Food Processing industry to the order of 1 for half of the sectors such as Service Station, Transportation, Health Services, and Local Government. This means that for each unit (acre-feet) change in direct water use by the Food Processing industry, total water use in the economy would change by 154.525 units. However, the shock to the economy is measured, not by unit change in direct water use, but by a change in final demand for the commodities. A table lists the estimated changes in output, income, employment, and water use for a $100,000 change in final demand in each sector. In the case of the Food Processing industry, these figures are $177,489, $22,772, 3.0 FTE, and 216.34 acre ft, respectively. (Cassar-FRC)
W82-01138

COMPUTER MODELING OF LOS ANGELES WATER RESOURCES,
Los Angeles City Dept. of Water and Power, CA.
B. W. Kuebler.
Journal of the American Water Works Association, Vol 73, No 7, p 341-345, July, 1981.

Descriptors: *Computer models, *Water resources development, *Water level fluctuations, Groundwater, Surface water, Groundwater recharge, Pumping, *Los Angeles, California.

Computer models for surface water and groundwater were developed to aid in the scheduling of operations and in planning for the future. The Owens-Mono surface water model is used to model the Mono and Owens River basins, which have four major reservoirs with a combined capacity of 288,000 acre-feet. The model schedules operations for the runoff year (April through March). Also, this model has been used to simulate the operations of the aqueduct system over a 31-year base period as part of a study of the environmental impact of groundwater pumping. The Los Angeles groundwater model is used to predict water level changes due to groundwater recharge and variations in the amount of pumping. The Owens Valley groundwater model is used to give a rough estimate of how the basin responds to various recharge and extraction schemes with existing and proposed wells. Developing or updating a computer model is a good way to comprehend how a resource functions, even if the model is not the best way of arriving at decisions on how to use that water resource. (Small-FRC)
W82-01168

DESIGN AND MERIT OF A RIVER-AQUIFER MODEL FOR OPTIMAL USE OF AGRICULTURAL WATER,
Colorado State Univ., Fort Collins. Engineering Research Center.
H. J. Morel-Seytoux, C. J. Daly, T. Illangasekare, and A. Bazaraa.
Journal of Hydrology, Vol 51, No 1-4, p 17-27, May, 1981. 5 Fig, 9 Ref.

Descriptors: *Irrigation programs, *Design criteria, Planning, Drought, Rivers, Aquifers, Groundwater, Wells, Surface water, *South Platte River, *Colorado, Agriculture, Model studies, Simulation, *Surface-groundwater relations.

Important steps in the design of a river-aquifer model for optimal use of agricultural water are discussed. The area under study consisted of a 90 mile reach of the South Platte River in the eastern plains of Colorado and of its associated alluvial aquifer. Irrigated agriculture is widely practiced in this area, with the major crops being corn, sugar beets, beans and alfalfa. Irrigation water comes mainly from surface water supplied by three reservoirs and an extensive system of distribution canals. Groundwater is used as a supplementary source through pumped wells. The study was made to find an optimum strategy of managing the river-aquifer system under drought conditions. Considerations to be included in the model design included system size and geometry, length of time steps and the total time horizon, lumping of parameters and variables, water allocation, and water rights. Once designed, the model was successfully applied to the field problem. The design procedures used made it possible to apply the model at a very moderate cost of $350 (US) for a simulation and still maintain very high accuracies in simulating the physical behavior. (Baker-FRC)
W82-01193

ANALYSIS OF NATIONAL WATER POLLUTION CONTROL POLICIES 1. A NATIONAL NETWORK MODEL,
Resources for the Future, Inc., Washington, DC.
L. P. Gianessi, and H. M. Peskin.
Water Resources Research, Vol 17, No 4, p 796-801, August, 1981. 1 Fig, 1 Tab, 27 Ref.

Descriptors: *Water quality, *Path of pollutants, *Water pollution control, Model studies, Network design, Mathematical models, Water pollution sources, Rivers, Lakes, Reservoirs, Bays, Urban runoff, Nonpoint pollution sources.

A water pollution network model was developed to study the implication of federal water pollution control policies on a national level. It consists of a water network, a set of assignment functions for injecting pollutants into the network, and equa-

tions or rules for transmitting the pollutants throughout the network. Bodies of water with average flows of 1000 cu ft per sec or greater and receptors of pollutants from major urban areas or two or more counties were chosen for inclusion in the model. However, some small, polluted rivers were included, and some large, pristine, rivers and short polluted tributaries were excluded. In all, the network contains 304 rivers, 175 lakes and reservoirs, 37 bays, 10 sections of Great Lakes shoreline, and 26 ocean shoreline segments. Nodes (1051 river and 249 other) were established at: major population centers, entrances of major tributaries, beginnings of estuaries, entrances to reservoirs, river mouths, and within very long river sections without other nodes. Each county, except for 13 completely arid counties, is assigned at least one node. Point discharges and urban runoff are assumed to enter the network at nodes; and nonpoint sources, between the nodes. Hydrodynamic data and geographical data were obtained from U.S. Geologic Survey publications and other sources. The pollution transport functions are used to convert injections of pollutants at the nodes to concentrations of pollutants at and between nodes. Although no formal testing of the model has been done, a deficiency is noticeable. Leaving out many small tributaries underrates the flow at the next downstream node. (Cassar-FRC)
W82-01292

ANALYSIS OF NATIONAL WATER POLLUTION CONTROL POLICIES 2. AGRICULTURAL SEDIMENT CONTROL,
Resources for the Future, Inc., Washington, DC.
L. P. Gianessi, and H. M. Peskin.
Water Resources Research, Vol 17, No 4, p 803-821, August, 1981. 5 Fig, 11 Tab, 30 Ref.

Descriptors: *Agricultural runoff, *Sediment control, *Water pollution control, *Path of pollutants, Model studies, Mathematical models, Water quality, Phosphates, Dissolved oxygen, Nitrogen, Biological oxygen demand, Nonpoint pollution sources.

A national water network model was used to predict the effects of several agricultural sediment control policies on water quality. The most widespread violations were found for total Kjeldahl nitrogen (TKN) and total phosphorus (TP), with fewer for BOD5 and dissolved oxygen. Three policies were simulated: (1) a point source control policy, (2) a cropland sediment control policy, and (3) full implementation of both policies. Model results suggest that the third alternative would result in significant improvement on water quality in about one-third of the river points in the country. Water quality violations would be reduced 31% for BOD5, 24% for TKN, 25% for TP, and 44% for dissolved oxygen. However, even with full implementation of point source and sediment control about half of the nation's rivers would violate TP and TKN standards. Maps depict which of the 105 regions of the country would have significantly fewer violations of each pollutant if a cropland sediment control policy were implemented. (Cassar-FRC)
W82-01293

A SURVEY OF MATHEMATICAL OPTIMIZATION MODELS AND ALGORITHMS FOR DESIGNING AND EXTENDING IRRIGATION AND WASTEWATER NETWORKS,
Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
C. E. Mandl.
Water Resources Research, Vol 17, No 4, p 769-775, August, 1981. 6 Fig, 28 Ref.

Descriptors: *Model studies, *Irrigation design, *Wastewater facilities, Network design, Mathematical models, Algorithms, Water conveyance, Water quality, Design criteria, Experimental design, Costs, Construction costs, Operating costs, Linear programming, Sensitivity analysis, Optimization.

Network models and algorithms useful in designing and expansion of irrigation and wastewater systems are reviewed. No one model dominates on the basis of both computational efficiency and quality of solution. Trying to minimize construction and/or operating costs typically results in a concave cost (objective) function due to economies of scale. For large networks (200 or more nodes) linear or piecemeal linear (separable) programming plus sensitivity analysis should be tried first. For smaller networks an integer programming approach described by several authors may be successful. If the network is a tree structure, the Polymeris (1978) or Converse (1972) algorithms are more efficient. However, none of the models considers water quality constraints, only optimal network design in terms of construction and/or operating costs. (Cassar-FRC)
W82-01296

POTENTIAL USE OF A STREAM-AQUIFER MODEL FOR MANAGEMENT OF A RIVER BASIN: CASE OF THE SOUTH PLATTE RIVER IN COLORADO,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
H. J. Morel-Seytoux, T. Illangasekare, M. W. Bittinger, and N. A. Evans.
Water Science and Technology, Vol 13, No 3, p 175-187, 1981. 5 Fig, 7 Ref. OWRT-B-076-COLO(6), OWRT-B-109-COLO(9), and OWRT-B-144-COLO(8).

Descriptors: *Water management, *Irrigation water, *Drought, *River basins, Water allocation, Agriculture, Aquifer management, Canal linings, Irrigation efficiency, Model studies, *South Platte River, Colorado, *Computer models, Simulation analysis.

A computer simulation study was conducted to determine the best water management strategy, particularly under drought conditions, for conjunctive use of surface and groundwaters for a 90-mile section of the South Platte River. Five runs of the model were made. The Historical Run used data for 1952-1961. Calculated river flow at Julesburg agreed with recorded flows. The Lined Canals Run proposed lining canals with seepage losses of 25% or more. Water allocation strategy consisted of allowing the diversion of the minimum of four quantities: water need, water right, legal water availability, and historical diversion. The Farm Efficiency Run assumed that irrigation efficiency improved from a historical value of 40-50% to 75% under the same water allocation strategy as the Lined Canals Run. The Pumping-as Needed Run allocated surface water as before, but allowed pumping up to existing capacity to meet crop needs unsatisfied by surface water supplies. The fifth run was a Combination Run. The best remedy for water supplies was to draw supplemental water from the aquifer wherever and whenever needed during drought. The resulting lowering of the water table would reach an equilibrium state within two years if no more land is put into production. Canal lining and increased farm efficiency, depending on surface water, would save only small amounts of water in times of drought when surface water supplies are small. This model study confirms previous work which concluded that wells should be pumped during dry years and allowed to recharge during years with normal stream flow. (Cassar-FRC)
W82-01301

SYSTEMS ANALYSIS,
Cornell Univ., Ithaca, NY.
J. R. Stedinger, and D. Pei.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 612-615, June, 1981. 56 Ref.

Descriptors: *Systems analysis, *Water pollution control, *Planning, *Water management, Regional planning, Storm water, Monitoring, Water quality, Model studies, Reviews, Nonpoint source pollution, Urban runoff, Eutrophication, Lakes, Wastewater treatment, Clean Water Act, *Literature review.

Literature on systems analysis applied to water management included methods useful in regional planning and development. Several papers concerned EPA Section 208 (Clean Water Act) studies and the differences in program implementation in similar areas. Marketable discharge permits, a tiered permit system, and taxation schemes to achieve desired pollutant abatement levels were discussed. Water quality models were developed, refined, and used in new applications. Some of the conclusions of these studies were: nitrification was the dominant cause of dissolved oxygen depletion in the Willamette River, Oregon; and low-flow augmentation was less costly than water treatment. Three models predicted different degrees of eutrophication in Lake LaFarge, Wisconsin. Models were applied to Great Lakes eutrophication and phosphorus loading. Books on water quality modeling, especially for rivers, were published. Nonpoint source pollution research concerned combined sewer overflows, the problems of STORM and SWMM models, a decomposition dynamic programming algorithm for determining optimal control of storm water, and a critique of current nonpoint pollution source models. Systems analysis and computers in wastewater treatment operation improved performance and efficiency, minimized costs, and helped choose optimum expansion designs. Decentralized treatment facilities produced higher dissolved oxygen concentrations than centalized facilities. Water quality monitoring and network design were reviewed and evaluated. Intervention analysis was used to determine the effects of wastewater treatment in phosphorus reduction and for estimating missing data. (Cassar-FRC)
W82-01303

STUDY OF A COMPLEX WATER RESOURCES SYSTEM WITH SCREENING AND SIMULATION MODELS,
Indian Inst. of Tech., New Delhi.
M. C. Chaturvedi, and D. K. Srivastava.
Water Resources Research, Vol 17, No 4, p 783-794, August, 1981. 6 Fig, 9 Tab, 15 Ref.

Descriptors: *Systems analysis, *Water resources development, *Linear programming, Model studies, Dams, Reservoirs, *Narmada River, *India, River basin development, Simulation, Planning, Multipurpose projects.

The Narmada River basin, India, was studied using a combination of a mathematical programming screening model and a simulation model. The screening models were used to find a reasonably small set of optimal design alternatives for a large complex multipurpose water resources system which includes six major dams. Two linear programming deterministic models were used, one continuous (LPDC) and one discontinuous (LPDD). Simulation analysis then supplied the near-optimum solution in terms of objective function. The LPDC model produced realistic and improved results when compared with values obtained by conventional design methods. The LPDC also specified output targets and capacities for better regulation of mean monthly flows at all sites. The LPDD model predicted excess reservoir capacity needed for drought and wet years and helped in selecting the range of variables for simulation by random sampling for the alternative selected by the LPDC model. (Cassar-FRC)
W82-01309

DAILY OPTIMIZATION OF POWER GENERATION IN CASCADE HYDROSYSTEMS (A STOCHASTIC APPROACH),
Institutul Politehnic din Bucuresti (Romania). Power Div.
A. Diacon, I. Seteanu, and R. Popa.
Journal of Hydrology, Vol 51, No 1/4, p 57-65, May, 1981. 5 Fig, 5 Tab, 4 Ref.

Descriptors: *Powerplants, *Optimization, Systems analysis, Planning, Model studies, Hydroelectric power, Electric power, Electric power production, Resources development.

A general model is proposed with the probability density functions of stochastic variables estimated according to hydrological conditions and operational practice of a cascade hydrosystem. The system considered is comprised of a cascade containing hydroelectric facilities and associated

buffer reservoirs located downstream of a major, multiannual regulating reservoir. Daily optimization of power generation for such a hydrosystem is very advantageous. Releasing of water through turbines during on-peak hours of the load-curve is desirable, while during off peak hours it is more suitable to store the inflow discharges in such a way that a more favorable energy production is obtained. The inflow discharges and the discharges for water supply uses of water storages are considered as random variables, with their probability density functions being estimated according to both hydrological conditions and operational practice. The reliability of the proposed model is proved by an actual numerical case study; the input-output data as well as the optimization algorithm are presented in detail. (Baker-FRC)
W82-01320

HYDROELECTRICAL MODEL FOR OPTIMAL OPERATION OF A SINGLE MULTIPURPOSE RESERVOIR,
National Water Plan Commission, Mexico City.
A. Guitron.
Journal of Hydrology, Vol 51, No 1/4, p 67-73, May, 1981. 2 Fig, 2 Tab, 5 Ref.

Descriptors: *Reservoirs, *Model studies, Irrigation practices, Stochastic models, Electric power production, Hydroelectric power, Operating policies, Administration, *Mexico.

A dynamic programming model is described in its application to the construction of a projected reservoir in the northwest zone of Mexico. The purposes to which the water in the reservoir is to be put include irrigation, electric energy production, flood control and water quality control. The operation policy is obtained for a fixed design, the physical objectives of the analysis being to determine the optimal releases and water storage of the reservoir during the operation period. Irrigation water volumes are treated in parametric form, establishing in this way a production function for energy and water, while satisfying the other restrictions on withdrawals and storage levels. The model which was developed was applied to a projected reservoir located on the Fuerte River in northwest Mexico. The historical mean annual stream-flow of Fuerte River at Huites station is 3.733 times 10 to the 9th power cubic meters, the useful capacity 3.91 times 10 to the 9th power cubic meters, and the dead capacity 0.28 times 10 to the 9th power cubic meters. The model results indicate the maximum peak energy that it is possible to produce for several levels of firm irrigation water. The mean secondary energy produced is also indicated. While the model is applicable to an operating policy for a single reservoir, the Huites project is part of a complex system requiring the integral operation of multiple reservoirs and irrigation areas. However, the model will be helpful in defining initial points for the search for an optimal operation policy of the total system. (Baker-FRC)
W82-01329

RURAL WATER SUPPLY AND RELATED SERVICES IN DEVELOPING COUNTRIES-COMPARATIVE ANALYSIS OF SEVERAL APPROACHES,
Bajard (Y.) Associates Ltd., Vancouver (British Columbia).
Y. Bajard, M. Draper, and P. Viens.
Journal of Hydrology, Vol 51, No 1/4, p 75-88, May, 1981. 3 Ref.

Descriptors: *Water resources development, *Planning, Resources development, Rural areas, Water supply development, Water requirements, Sanitation, Water demand, Africa, Tropical regions, *Developing countries.

Technical and educational aspects of rural water supply and sanitation programs are reviewed for Kenya, Cameroon, Senegal, The Gambia, Mali, Ivory Coast, Ghana, Benin and Ethiopia. Water availability and distribution in tropical Africa are generally poor. Several problems come to light on examining the various development schemes either proposed or underway. There is a general lack of recognition by host countries and donor agencies that water supplies and sanitation are inseparable aspects of development which must be tackled together. There is, in general, a reluctance to give due consideration to non-technical aspects of the problem. It is not widely realized that western technology, while efficient on the short term but sociologically brutal, may not be the best solution to the water problem. Training is lacking in both operation and management areas. There is a general lack of recognition that the projects must be seen within an overall framework, usually the country as a whole, even though action may be limited to a small part of that country. The projects are often conceived at a distance without sufficient reference to the local context. A plan is presented to take each of these shortcomings and devise a system of overcoming them. (Baker-FRC)
W82-01330

PREDICTING STREAM SALINITY CHANGES IN SOUTH-WESTERN AUSTRALIA,
Perth Public Works Dept. (Australia).
I. C. Loh, and R. A. Stokes.
Agricultural Water Management, Vol 4, No 1/3, p 227-254, 1981.

Descriptors: *Salinity, *Water pollution sources, Groundwater pollution, Land management, Farming, Solute transport, Model studies, Catchments, Reforestation, Water supply, *Agricultural runoff, *Forest watersheds, Streams, Inflow, *Australia.

The range of hydrologic responses and salinity variations of rivers and streams which drain forested and agricultural land in the Darling Range of south-western Western Australia are described. Appropriate approaches to modeling stream salinity changes to solve different problems are discussed, and a model is described which can be used to predict the annual salinity and flow of a large river system subject to a long history of permanent clearing. The geology of the Darling Range is dominated by the Archean Shield, a granitic basement underlying the lateritic soil profiles of the region. Soil associations have generally formed in situ and are characterized by lateritic gravels and duricrust overlying pallid zones of sandy clays or clay and a zone of weathered bedrock. Natural forest vegetation is characterized by a variety of Eucalyptus species with deep roots extended into the subsoils and weathering profile. The regional model described predicts the flow and salinity from a 2830 km square catchment, the Wellington Reservoir Catchment, subject to a long clearing history, and is designed to assist planning for long term catchment management. The model is based on a general quantitative knowledge of the hydrologic characteristics of small catchments within different rainfall zones across the catchment and represents the compilation of results from 10 years of study. Low salinities of the Darling Range prior to clearing were seen to dramatically increase in salt load following clearing. Current findings suggest that the mostl is overpredicting salinities in dry years. Improvements could be gained by further study of groundwater discharge to streams from year to year and a more careful study of effects of different geometric patterns of clearing and aquifer dimensions on groundwater discharge. (Baker-FRC)
W82-01350

METHODS FOR GENERATING ALTERNATIVE SOLUTIONS TO WATER RESOURCES PLANNING PROBLEMS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
S-Y. Chang, E. D. Brill, Jr., and L. D. Hopkins.
Water Resources Center, University of Illinois, Research Report No 160, July, 1981. 114 p, 17 Tab, 14 Fig, 29 Ref. S-078-ILL.

Descriptors: *Model studies, *Optimization, Resources development, Alternative planning, Multiobjective planning, *Water resources development, Mathematical models, System analysis, Wastewater treatment, Planning, Comprehensive planning, Project planning.

An optimization model is generally not a perfect representation of a complex water resources planning problem because not all important issues can be captured in a model. However, optimization models can be used to generate planning alternatives that are good and different, though not optimal, so that the decision maker can examine a wide range of alternatives. This approach is called modeling to generate alternatives (MGA). Several MGA methods--a random method, a branch and bound/screening (BBS) method, a Hop-Skip-Jump (HSJ) and a Fuzzy HSJ method--are described, and the potential use of these methods for generating good and different alternative solutions is assessed. The methods are illustrated using a wastewater treatment system planning problem, which is formulated as a mixed integer programming (MIP) model. The results suggest that all four MGA methods can be used in a complex water resource planning process to generate planning alternatives that are good and different. The common disadvantage of the quantitative methods of measuring differences among alternatives is that they cannot measure how far, in the spatial sense, the changes are made. With the HSJ method, the differences among alternatives are greater for the first several alternatives and decrease for additional alternatives. The Fuzzy HSJ method generates alternatives with the same general trend as HSJ. With the random generation method, the possibility of generating the same alternative is larger for a small planning problem than for a large one. The two-step BBS method uses the APEX code, then a screening process to select solutions that are different from each other. (Garrison-Omniplan)
W82-01449

GENERATING ALTERNATIVE SOLUTIONS FOR DYNAMIC PROGRAMMING MODELS OF WATER RESOURCES PROBLEMS,
Illinois Univ. at Urbana-Champaign. Dept. of Landscape Architecture.
L. D. Hopkins, E. D. Brill, Jr., and B. Wong.
Water Resources Center, University of Illinois, Research Report No 163. August, 1981. 31 p, 9 Fig, 2 Tab, 11 Ref. Append. S-078-ILL.

Descriptors: *Alternative planning, *Model studies, *Multiobjective planning, Flood plain management, Management planning, Mathematical models, Model testing, Land use, Long-term planning, Flood plains, Bottomland, Projections, *Water management.

Using modeling to generate alternative (MGA) techniques, three methods to identify different, feasible alternative solutions to dynamic programming problems concerning water resources are evaluated. The methods, which differ in the procedure for identifying different alternatives, are: (1) adapting the kTH best policy method based on a difference constraint; (2) generalizing this method by treating difference and the known objective as two components to be weighted; and (3) searching a modified trace-back for solutions of maximum difference. Applying the second technique to a floodplain management model resulted in a solution in which all land use decisions, except one non-floodplain land use and one floodplain land use, were different from the decisions in the original solution. The economic rent objective was 11 percent lower than in the original solution. The outflow at the base of the watershed was approximately 26,000 cubic feet per second, compared with 20,000 cubic feet per second in the original solution. This illustrates that for a realistic problem, a variety of alternatives can be obtained without greatly reducing the economic rent from the optimal solution to a model of the problem. The intent to obtain alternatives that are perceivable as different with respect to implicit knowledge is, therefore, satisfied. This analysis could be used as a mental blockbuster to confront the analyst with policy options that are suggested by consideration of alternatives rather than by the original solution or past experience. The weighted difference approach is the most promising among the approaches considered. (Garrison-Omniplan)
W82-01450

PERFORMANCE EVALUATION OF A STOCHASTIC OPTIMIZATION MODEL FOR RESERVOIR DESIGN AND MANAGEMENT WITH EXPLICIT RELIABILITY CRITERIA,

Purdue Univ., Lafatette IN. School of Civil Engineering.
For primary bibliographic entry see Field 8A.
W82-01462

ON IDENTIFICATION AND VALIDATION OF SOME GEOTHERMAL MODELS,
Department of Scienfitic and Industrial Research, Lower Hutt (New Zealand). Physics and Engineering Lab.
L. J. Fradkin, M. L. Sorey, and A. McNabb.
Water Resources Research, Vol 17, No 4, p 929-936, August, 1981. 2 Fig, 24 Ref.

Descriptors: *Geothermal studies, *Model studies, *Well hydralics, Groundwater movement, Wairakei, *New Zealand, Thermal water, Mathematical models, Deep wells, *Geothermal resources.

The best of several models for production in the Wairakei geothermal field, New Zealand, was a lumped parameter model identified as a slow drainage model in which the upper two-phase portion of the reservoir serves mainly as a source of liquid for the underlying liquid region from which most of the production is obtained. This study also considered general models, reduced models, distributed parameter models, and combinations of these. Models were validated by comparing their forecasting powers with identified parameter values and by testing these identified values against additional data. Although the chosen slow drainage model gives a significantly simple conception of the reservoir, it is quite adequate for describing the production field's response with a minimum of parameters. It also provides good estimates of field parameters such as porosity, permeability, and recharge-storage ratio. (Cassar-FRC)
W82-01467

MANAGEMENT CONCERNS FOR SWIMMING, TUBING, AND WADING IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK,
Great Smoky Mountains National Park, Gatlinburg, TN. Uplands Field Research Lab.
G. L. Larson, and W. E. Hammitt.
Environmental Management, Vol 5, No 4, p 353-362, July, 1981. 8 Fig, 1 Tab, 12 Ref.

Descriptors: *Recreation demand, *Water sports, *Environmental effects, Swimming, Parks, Soil compaction, Erosion, Stream banks, Streams, *Great Smoky Mountain National Park.

The great abundance of swimmers and innertube floaters along streams in the Great Smoky Mountains National Park made necessary this study on potential resource impacts. The main types of aquatic use other than fishing are described. The following were determined: the amount of each use, patterns of use, site use at each location, and potential impacts and user conflicts. Sampling was conducted at several sites on three streams. Use was concentrated during the afternoons and at certain streams and study sites most appropriate for the activity. Major impacts were soil compaction and erosion along the streambanks and the physical disturbance of the stream bottoms due to moving stones to construct temporary dams and raceways. Management objectives for the area will have to be specified, and the amount and character of chage permitted to occur in these streams because of recreational use must be determined. Further study is needed to determine that level of aquatic use that a stream can support without excessive damage. (Small-FRC)
W82-01475

SIMULATION OF DAILY WEATHER DATA USING THEORETICAL PROBABILITY DISTRIBUTIONS,
Cornell Univ., Ithaca, NY. Dept. of Plant Pathology.
For primary bibliographic entry see Field 2B.
W82-01526

INTERDISCIPLINARY ENVIRONMENTAL ANALYSIS FOR TIMBER SALE PLANNING,
Klamath National Forest, Yreka, CA.
F. H. Jackson.
Water Resources Bulletin, Vol 17, No 2, p 301-306, April, 1981. 1 Fig, 3 Tab, 3 Ref.

Descriptors: *Planning, *Interdisciplinary studies, Water resources development, *Forestry, Environmental control, Environmental policy, Decision making, Administrative decisions, *California, Klamath National Park.

The systematic interdisciplinary process currently used for the development, evaluation, and selection of alternatives for timber harvest projects on the Happy Camp Ranger District of Klamath National Forest in northern California is described. The process begins with an inventory of resources and a team of specialists headed by a decision-maker, as well as a set of management objectives and constraints. It uses a mechanism which will set up conditions conducive to identification of appropriate alternatives reflecting the degree to which single alternatives can fulfill all objectives. A decision package of effectively displayed information is prepared, and a decision is made and documented. An impact matrix sheet is prepared, listing all resource factors and all alternatives for a given area on one sheet. Hydrologic resource factors considered are stream stability, stream temperature and stormflow turbidity. The specialists involved, including a water resources specialist, identify problem areas, predict impacts of proposed treatments, and help to develop management strategies. The team includes a decision-maker who is ultimately responsible for the project. (Baker-FRC)
W82-01539

MANAGING LAND TO MEET WATER QUALITY GOALS,
Economics and Statistics Service, Washington, DC. Natural Resource Economics Div.
For primary bibliographic entry see Field 4D.
W82-01557

6B. Evaluation Process

HYDROPOWER LOSSES FROM NAVIGATION IN THE SNAKE-COLUMBIA RIVERS: 1978-79,
Washington State Univ., Pullman. Dept. of Environmental Science.
For primary bibliographic entry see Field 6D.
W82-01139

A SURVEY OF MATHEMATICAL OPTIMIZATION MODELS AND ALGORITHMS FOR DESIGNING AND EXTENDING IRRIGATION AND WASTEWATER NETWORKS,
Massachusetts Inst. of Tech., Cambridge. Operations Research Center.
For primary bibliographic entry see Field 6A.
W82-01296

EFFECT OF INVESTMENTS IN WATER SUPPLY AND SANITATION ON HEALTH STATUS: A THRESHOLD-SATURATION THEORY,
Michigan Univ., Ann Arbor. School of Public Health.
H. I. Shuval, R. L. Tilden, B. H. Perry, and R. N. Grosse.
Bulletin of the World Health Organization, Vol 59, No 2, p 243-248, 1981. 6 Fig, 13 Ref.

Descriptors: *Public health, *Cost-benefit analysis, *Water supply development, Developing countries, Threshold-saturation theory, Planning, Waste disposal, Social aspects, Economic aspects, Water resources development.

The threshold-saturation theory is proposed to relate investments in sanitation and water supply to health. Three variables are considered: health status, socioeconomic status, and sanitation level. The two-tiered S-shaped logistic form assumes that at the lower end of the socioeconomic spectrum there is a threshold below which investments in community water supplies or sanitation alone result in little improvement in health status. At the other end of the socioeconomic scale, there is a point of saturation beyond which investments in conventional community sanitation facilities produce no further health benefits. Preliminary support for this theory was obtained by using published data on sanitation level, life expectancy, and adult literacy rates for 65 developing countries. (Cassar-FRC)
W82-01331

EXPANSION OF EFFLUENT CONSTRAINED TREATMENT PLANTS,
Newcastle Univ., New South Wales (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W82-01355

PRELIMINARY DESIGN AND COST ESTIMATES FOR REMEDIAL ACTIONS AT HAZARDOUS WASTE DISPOSAL SITES,
JRB Associates, Inc., McLean, VA. Waste Management and Resource Recovery Div.
For primary bibliographic entry see Field 5G.
W82-01435

INPUT AND OUTPUT CONSTRAINTS AFFECTING IRRIGATION DEVELOPMENT,
Michigan Univ., Ann Arbor. School of Natural Resources.
G. Schramm.
Journal of Hydrology, Vol 51, No 1-4, p 1-16, May, 1981. 1 Fig, 5 Tab, 17 Ref.

Descriptors: *Irrigation design, *Planning, Design criteria, Irrigation practices, Irrigation programs, Farming, Agriculture, Decision making, Administrative decisions, *Mexico.

The development of an extensive irrigation project in Mexico for the purposes of increasing agricultural output and alleviating rural poverty and unemployment is reviewed, with emphasis on the manner in which shifting projections and parameters change the overall benefits initially expected from such a long term project. Government allocations to the agricultural sector increased 7-fold from 1970 to 1975. However, other supports were also needed, such as short- and long-term credit, availability of fertilizers, seeds and insecticides, and accessibility to markets and marketing facilities. These factors are termed input constraints. Output constraints are basically market related. They occur because hoped-for, predicted markets for certain crops do not materialize or are available only at prices far below those predicted in the project planning stage. It is suggested that, in countries where conditions are such that a wide variety of crops will fluorish, new projects should generally be evaluated on the basis of low-value crop production only. When high value are included in this evaluation, there must be specific reasons to believe that this product will be superior to already existing ones. Expected price levels for all specialty crops should be based on observed price levels in the local or regional markets to be served. Studies should be undertaken on an ongoing basis to estimate yearly the likely growth in demand for higher value crops. The necessary inputs, including education and demonstration plots, must be figured into the cost-benefit analysis of the project from the beginning. (Baker-FRC)
W82-01476

EXTRACTION TIMING AND ECONOMIC INCENTIVES FOR GEOTHERMAL RESERVOIR MANAGEMENT,
Woodward-Clyde Consultants, San Francisco, CA.
For primary bibliographic entry see Field 4B.
W82-01504

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

ON WATER TARIFF EQUALIZATION POLICIES,

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Applied Engineering.
S. H. Hanke.
Water/Engineering and Management, Vol 128, No 8, p 33-34, August, 1981. 12 Ref.

Descriptors: *User charges, *Water policy, *Policy making, Water costs, Public policy, Pricing, Administrative decisions, Regional planning, Economic aspects, Investment.

Intra-system water tariff equalization policies based on forward-looking costs are discussed. This type of policy requires all customers in a certain customer class to pay the same price per unit volume and the same fixed charge per period regardless of which local system they are in. This type of system has been proposed in France and the United Kingdom and is believed to be necessary for the development of an equitable regional or national strategy for water development. Equalization policies mean that users in low-cost systems subsidize users in high-cost systems. One disadvantage is that since price and charges are not related to the real cost of water, inefficiency may be encouraged. Where the political power of the low-cost and high-cost users is equal, or where the power of the high-cost users dominates, overinvestment will occur in the high-cost systems and underinvestment in the low-cost systems. (Small-FRC)
W82-01175

SUPPLY-DEMAND COORDINATION IN WATER RESOURCES MANAGEMENT,
Centro Teoria dei Sistemi, Milano (Italy).
G. Guariso, D. Maidment, S. Rinaldi, and R. Soncini-Sessa.
Water Resources Research, Vol 17, No 4, p 776-782, August, 1981. 5 Fig, 3 Tab, 10 Ref.

Descriptors: *Water supply, *Water demand, *Interbasin transfers, *Water resources management, Optimization, Water management, Irrigation, Water transfer, Water delivery, Benefits, Cost-benefit analysis, Algorithms, Marginal costs, Northwest Water Plan, *Mexico, Pricing.

Optimal water supplies and demands in a network were determined by an iterative algorithm which combines the results of models for each supply and demand unit. It works with marginal benefits and costs rather than total benefits and costs. The key idea is that the cost of delivering a unit of water must be equal to the benefit generated at that point. Some simplifying assumptions made are: water quality is not considered, all flows are available at the same time, and all supplies have the same reliability. The method is applied to the proposed Northwest Water Plan in Mexico, involving transfer of water from south to north along the Mexican coast of the Gulf of California. Declining groundwater levels and seawater intrusion are the problems behind this proposed transfer. The system consists of four supplies (one groundwater system and three reservoirs) and four irrigation demand areas. If the transfer scheme is built according to plan, the annual total net benefit from crop production in the region would increase by 6% to $784.2 million; construction and maintenance costs are estimated at $16.1 million per year; and the benefit-cost ratio is 2.7. The water price in the source region would rise from 4 cents to 9 cents per cu meter and fall from 24 cents to 10.5 cents in the receiving area. Solving the problem by classical price coordination methods requires an eight-dimensional search, while the method presented in this paper is one-dimensional. (Cassar-FRC)
W82-01299

ECONOMICS,
Clemson Univ., SC.
For primary bibliographic entry see Field 5G.
W82-01304

6D. Water Demand

WATER MULTIPLIERS--REGIONAL IMPACT ANALYSIS,
Hawaii Univ., Honolulu. Dept. of Agricultural and Resource Economics.
For primary bibliographic entry see Field 6A.
W82-01138

HYDROPOWER LOSSES FROM NAVIGATION IN THE SNAKE-COLUMBIA RIVERS: 1978-79,
Washington State Univ., Pullman. Dept. of Environmental Science.
C. F. Culver, and C. B. Millham.
Water Resources Bulletin, Vol 17, No 3, p 501-503, June, 1981. 1 Tab, 7 Ref.

Descriptors: *Energy loss, *Electric power, *Locks, Dams, Hydroelectric power, Powerplants, Dams, Recreation, Transportation, *Navigation, Rivers, *Snake River, *Columbia River, Washington, Boating, Water use, Water demand.

Power losses from commercial and recreational lockages on the Snake-Columbia River complex were, respectively, 100,206,000 and 14,900,000 kWH in 1977 (a year of low flow), 125,958,000 and 28,748,000 kWH in 1978, and 127,483,000 and 34,259,000 kWH in 1979. Losses for 1978-79 would have met power requirements for 10,500 Washington State households for 2 years (at an annual rate of 15,000 kWH per household). Any boat traveling from Portland, Oregon, to Lewiston, Idaho, and back uses a minimum of 8 lockages at a total energy loss of 77,000 kWH or replacement cost of $3,000. Planned low-head hydropower development sites in the State of Washington would produce energy quantities comparable to the losses due to pleasure boat lockages at the present dams. The authors question whether commercial towboats should continue to enjoy cost-free passage and whether there are more energy-conserving methods of transporting recreational boats over dams. (Cassar-FRC)
W82-01139

PREFERENCES FOR ALLOCATING RIVER RECREATION USE,
Montana Univ., Missoula. School of Forestry.
S. F. McCool, and J. Utter.
Water Resources Bulletin, Vol 17, No 3, p 431-437, June, 1981. 6 Tab, 18 Ref.

Descriptors: *Recreation demand, *White water, *Allotments, Surveys, Middle Fork, *Salmon River, *Idaho, Allocation of resources, Resource allocation, Rivers, Permits, Water management, Water policy, Regulations.

Allocation of white water stream recreational use between commercial and private sectors was the subject of a questionnaire to which 1,166 individuals responded during the 1978 river floating season at Middle Fork of the Salmon River, Idaho. The 3 groups (commercial users, private users, and those whose applications for a trip permit were rejected) most preferred the Even-Pool allotment technique (a 50-50 split with leftover allotments going to the other sector). The Middle Fork System (46% for commercial use, 54% for private use) was also highly favored. As a group, the commercial users liked Advance Reservation first and Knowledge and Skill Requirements, second. Private users and rejectees ranked Lottery first, and Knowledge and Skill Requirements, second. There appeared to be no relationship of the importance of stress release/escape scale to the allocation techniques. The results of this study show that river managers may have considerable latitude in selecting allocation techniques. Users appear to prefer allocation techniques which they have experienced favorably in the past, which seem fair, and which do not intrude on the activities on-site. Other methods which received more than 50% approval from any one of the groups were: Historical Use, Even Split (50-50), Percentage of Disappointment (a certain percentage of applicants from each sector), Treat Everyone the Same, and Lottery-Reservation. (Cassar-FRC)
W82-01181

SUPPLY-DEMAND COORDINATION IN WATER RESOURCES MANAGEMENT,
Centro Teoria dei Sistemi, Milano (Italy).
For primary bibliographic entry see Field 6C.
W82-01299

WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING; BRAZOS RIVER BASIN, TEXAS-NEW MEXICO.
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
Available from the National Technical Information Service, Springfield, VA 22161 as FERC-0059, Price codes: A02 in paper copy, A01 in microfiche. Planning Status Report FERC-0059, Revised 1980. 14 p, 3 Fig, 6 Tab.

Descriptors: *Water resources development, *Hydroelectric power, Flood control, Cooling water, *Reservoirs, Storage reservoirs, Thermal powerplants, Consumptive use, Saline water, *Multipurpose reservoirs, *Brazos River basin, Texas, New Mexico.

The Brazos River basin heads in eastern New Mexico about 25 miles northwest of the city of Clovis and extends in a southeasterly direction diagonally across Texas to the Gulf of Mexico, with an associated area that includes the coastal drainage north and east of the Brazos River to Galveston Bay. Average annual precipitation in the basin varies from 17 inches in the extreme headwater area to 46 inches near the Gulf of Mexico. There are 38 reservoirs in the basin (existing or under construction) with storage capacities in excess of 5,000 acre-feet. Nine of these are Federal projects, and two existing reservoirs support hydroelectric facilities. All of the Federal and one of the non-Federal reservoirs have space allocated for storage of floodwaters. There are 242 flood-water retarding structures with about 1,400 sq mi of drainage area. Water withdrawn for cooling purposes was estimated to be 1,547 million gallons per day with an estimated consumption rate of 38 million gallons per day. Potential hydroelectric projects in the Brazos River basin include Wynn Mountain, Inspiration Point, Hightower, DeCordova Bend, Bee Mountain, Belton, and a third unit at Possum Kingdom. There are twelve potential storage reservoirs in the basin. There may be 20 steam-electric generating plants in operation with generating capacities of 25 megawatts or greater located in the area by 1985. Fresh and saline water withdrawals for cooling purposes are estimated at 111 and 1,242 million gallons per day, respectively. The consumption rates for fresh and saline water are estimated at 74 and 8 million gallons per day, respectively. (Moore-SRC)
W82-01439

WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING; SAVANNAH AND EDISTO RIVER BASINS AREA; GEORGIA-SOUTH CAROLINA-NORTH CAROLINA.
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
Available from the National Technical Information Service, Springfield, VA 22161 as FERC-0075, Price codes: A02 in paper copy, A01 in microfiche. Planning Status Report FERC-0075, Revised February 1981. 19 p, 3 Fig, 6 Tab.

Descriptors: *Water resources development, *Hydroelectric plants, *Savannah River basin, *Edisto River basin, Reservoirs, Flood control, Recreation, Navigation, Cooling water, Wild rivers, Harbors, Water supply, Planning, *Multipurpose reservoirs, Georgia, South Carolina, North Carolina.

This revised report presents updated information on the water resources of the Savannah and Edisto River Basins, and information on new and planned developments. There are 17 hydroelectric developments in the Savannah basin, existing or nearing completion, and none in the Edisto basin. The total installed capacity will be 1,712,830 kw. The reservoirs also provide flood-control storage capacity, and recreation. Below Augusta, a channel 9 ft deep and 90 ft wide is maintained. There are five steam-electric generating plants which withdraw a total of 2,363 mgd of water for cooling purposes. In the two basins 14 sites have been identified for potential hydroelectric projects. The Chattooga River is

the only river in the basin presently included in the National Wild and Scenic Rivers System; several others are being considered for inclusion. Fifteen retired hydroelectric projects have the potential for redevelopment. The steam-electric cooling water requirements are projected to be 599 mgd in 2000. Major studies are in progress to determine if any modifications should be made to the existing Savannah Harbor project, and to investigate the water supply, flood control, drainage and storm runoff, recreation, navigation, beach erosion, and fish and wildlife of the Savannah area. (Brambley-SRC)
W82-01440

WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING; AMERICAN RIVER BASIN, CALIFORNIA.
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
Available from the National Technical Information Service, Springfield, VA 22161 as FERC-0076, Price codes: A02 in paper copy, A01 in microfiche.
Planning Status Report FERC-0076, Revised March 1981. 18 p, 3 Fig, 5 Tab.

Descriptors: *Water resources development, *Hydroelectric plants, *American River, California, Reservoirs, Irrigation, Cooling water, Flood control, Storage capacity, Wild rivers, Diversion channels, Water demand, Planning, *Multipurpose reservoirs.

This revised report presents updated information on the water resources of the American River Basin and information on new and planned developments. There are 15 hydroelectric plants existing or under construction, and three license applications are pending. Total installed capacity is 1,046,715 kw, and the reservoirs also provide water for irrigation, power plant cooling, and municipal and industrial uses, and provide storage capacity for flood control. The only steam-electric plant is a nuclear plant which draws 8 mgd of water from the river for cooling purposes. This is expected to increase to 59 mgd by 2000. A segment of the North Fork of the American River is included in the National Wild and Scenic Rivers System, and a segment of the South Fork is being considered. Thirteen sites have been identified as having potential for hydroelectric development. Some of these sites may become part of multi-site projects, involving diversion pipelines and tunnels. Development will be subject to other water demands, including municipal and industrial supplies, flood control, water quality, and fish and wildlife, and to regulations specifying minimum flows in the river. (Brambley-SRC)
W82-01441

ORGANIC CONTAMINATION OF GROUND WATER: TELL IT ALL,
Dedham Water Co., MA.
For primary bibliographic entry see Field 5C.
W82-01474

HYDROPOWER--AN OLD TECHNOLOGY FOR A NEW ERA,
Worldwatch Inst., Washington, DC.
For primary bibliographic entry see Field 4A.
W82-01593

6E. Water Law and Institutions

NEBRASKA GROUND WATER LAW AND ADMINISTRATION,
J. D. Aiken.
Nebraska Law Review, Vol 59, No 4, p 917-1000, 1980. 448 Ref.

Descriptors: *Nebraska, *Water law, *Groundwater management, Water policy, Legal aspects, Groundwater, Water rights, Water quality, Groundwater mining, Irrigation, Legislation.

Nebraska is rich in groundwater when compared to other western states. In spite of this, groundwater is in short supply in many parts of the state. Although 87 percent of the groundwater used in Nebraska in 1975 was for irrigation, groundwater also supplied 99 percent of total municipal water use, 83 percent of rural domestic and stock watering use, 78 percent of cooling water for power plants, and 100 percent of self-supplied industrial water use. The historical development of Nebraska groundwater law is discussed decade by decade, beginning with the windmill era existing prior to 1930, and including descriptions of the technological and historical conditions affecting groundwater development and use and discussion of the effects of these conditions on the evolution of Nebraska groundwater law. Finally, Nebraska groundwater law and policy are examined with respect to the institutional framework, rights of use, groundwater transfers, well interference conflicts, groundwater mining, conflicts between surface and groundwater users, and groundwater quality. While well interference conflicts in Nebraska are resolved through a combination of common law doctrines of reasonable use and correlative rights and of statutory preferences, there is no clear basis for the resolution of surface-groundwater disputes. The status of groundwater transfers is also unclear. State groundwater management objectives are lacking, and groundwater quality protection is limited. Continued groundwater development and mining can be expected to force legislators and judges to address groundwater policy issues in the future. (Carroll-FRC)
W82-01236

LAW,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
W. E. Cox, and W. R. Walker.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 617-619, June, 1981. 41 Ref.

Descriptors: *Water law, *Legal aspects, *Water pollution control, Legislation, Reviews, Water quality standards, Planning, Effluent limitations, Nonpoint pollution sources, Enforcement, Judicial decisions, Wastewater treatment, *Literature review.

The recent reduction in significant additions to water quality legislation has produced a reduction in literature on the legal aspects of water pollution. Some recent papers concerned institutional structures for water quality protection and the lack of coordination between water quality and quantity planning. Congress was accused of turning decision making over to the public and the courts. Several authors discussed the Clean Water Act, the nonpoint source pollution problem in the Great Lakes, and effluent limitation and water quality standards. Some of the court cases reviewed concerned challenges to effluent limitations in the crushed stone and mining industries, a carbon tetrachloride spill in the Ohio River basin, interpretation of the Clean Water Act covering oil and hazardous waste spills, and spill penalties. Other subjects discussed were: the impact of Safe Drinking Water Act control measures on drinking water suppliers, whether the consumer or polluter should bear costs of treatment, proposed Safe Drinking Water Act amendments and their effect on groundwater quality, EPA enforcement activities, and marine pollution on the international scale. (Cassar-FRC)
W82-01302

FEDERAL COMMON LAW OF NUISANCE EXPANDS,
E. M. Sommer.
Natural Resources Journal, Vol 21, No 2, p 419-423, April, 1981. 22 Ref.

Descriptors: *Common law, *Judicial decisions, *State jurisdiction, Legal aspects, *Water pollution control, Industrial wastes, Polychlorinated biphenyls, *Illinois.

The case of Illinois v. Outboard Marine Corporation is reviewed, in which Illinois filed action against the company for allegedly discharging highly toxic polychlorinated biphenyls (PCBs) from its Waukegan, Illinois plant into North Ditch, Waukegan Harbor, and Lake Michigan. The federal government also filed a complaint under the Refuse Act, the Federal Water Pollution Control Act, and the federal common law of nuisance. The courts significantly expanded the federal common law of nuisance by holding that Illinois had a federal common law cause of action in nuisance against an in-state pollution source. As a result of the litigation, the federal common law of nuisance now appears to extend to navigable waters that are purely intrastate. Thus, there is now an additional tool for combatting pollution within territorial boundaries. Also, states can now sue intrastate polluters on the basis of federal common law without satisfying the federal jurisdictional requirement of diversity. (Small-FRC)
W82-01337

THE WORKINGS OF THE CONTROL OF POLLUTION ACT IN TIDAL WATERS: A VIEW OF THE MINISTRY OF AGRICULTURE, FISHERIES AND FOOD,
Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Lab.
P. C. Wood.
Water Pollution Control, Vol 80, No 2, p 180-188, 1981. 4 Ref.

Descriptors: *Pollution control, *Legal aspects, Regulations, Permits, Law enforcement, Estuaries, Planning, *United Kingdom, *Tidewater, Effluents, Discharge permits, Fisheries.

The probable future involvement of the British Ministry of Agriculture, Fisheries and Food (MAFF) with the part of the Control of Pollution Act 1974 related to tidal waters is considered. Some of the technical problems of relevance to the MAFF which are likely to be encountered by the authorities are also considered. Under Part II of the Act, water authorities will be required to issue consents for new and existing discharges. This should be based on the application of quality objectives which, among other things, will require the designation of the use of estuaries or parts of estuaries. Environmental quality standards needed to meet these quality objectives must be established. The application of discharge control based on quality objectives requires experience with the complexity of marine ecosystems, and with conditions in the specific area. The setting of consent conditions for new or existing discharges will require the MAFF to give its views to the Secretary of State within six weeks of publication of proposed conditions. (Baker-FRC)
W82-01383

THOUGHTS ON THE NEED TO CONTROL DISCHARGES TO ESTUARIAL AND COASTAL WATERS,
Department of the Environment, London (England).
P. H. Garnett.
Water Pollution Control, Vol 80, No 2, p 172-179, 1981. 6 Ref.

Descriptors: *Estuarine environment, *Pollution control, Legal aspects, Planning, Coastal waters, International waters, Organizations, Management, International agreements, Estuaries, *United Kingdom.

Public opinion has begun to manifest itself in England toward desiring cleanup of polluted estuaries and coastal waters. This attitude is reflected in the Third Report of the Royal Commission on Environmental Pollution and in the report of the Ministry of Housing and Local Government Working Party on Sewage Disposal, 1970. Part II of the Control of Pollution Act calls for control of all discharges of sewage and industrial effluent to all non-tidal and tidal rivers, estuaries and coastal waters. In order that tidal water quality objectives may be met, a first step would be to establish a classification of tidal-water quality. There also are international legislative concerns which influence the implementation of Part II of the Control of Pollution Act. In particular, the Paris Convention is of concern, which seeks to eliminate pollution from land-based sources. The cost of implementation is briefly considered. (Baker-FRC)
W82-01384

USE OF THE CONTINGENCY FUND AT STRINGFELLOW HAZARDOUS WASTE DISPOSAL SITE,
Coast Guard, Hamilton AFB, CA. Pacific Strike Team.
For primary bibliographic entry see Field 5G.
W82-01416

PRACTICAL ASPECTS OF GROUND WATER MONITORING AT EXISTING DISPOSAL SITES,
Law Engineering Testing Co., Atlanta, GA.
For primary bibliographic entry see Field 5G.
W82-01421

SURFACE WATER MANAGEMENT AT HAZARDOUS WASTE SITES,
Dames and Moore, Atlanta, GA.
For primary bibliographic entry see Field 5G.
W82-01429

MIDDLESEX COUNTY SEWERAGE AUTHORITY V. NATIONAL SEA CLAMMERS ASSOCIATION: IMPLIED PRIVATE RIGHTS OF ACTION FOR DAMAGES UNDER THE FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972,
Lewis and Clark Coll., Portland, OR. Northwestern School of Law.
P. J. Manning.
Environmental Law, Vol 12, No 1, p 197-229, Fall, 1981. 265 Ref.

Descriptors: *Water law, *Judicial decisions, *Private rights, Legal aspects, *Water pollution control, Water pollution effects, Federal Water Pollution Control Act, *Shellfish, Middlesex County Sewerage Authority, National Sea Clammers Association.

The Supreme Court's opinion on the Middlesex County Sewerage Authority v. National Sea Clammers Association case did not settle the question of implied private rights of action under federal statutes. The Association filed suit in federal district court, complaining that various government officials had permitted toxic waste dishcarges into waters entering the Atlantic Ocean, where a massive algal bloom and subsequent collapse killed large numbers of shellfish. The case was dismissed in the district court for lack of jurisdiction. The Third Circuit Court of Appeals ruled that individuals injured by pollution violations of the Federal Water Pollution Control Act could seek damages. On appeal, the Supreme court rejected the Appeals Court conclusion, holding that Congress intended that private remedies in addition to those expressly provided should not be implied. Although this decision was correct, the haphazard use of the Cort v. Ash test in the analysis resulted in confusion in lower court rulings. Federal acts to control water pollution are reviewed, as well as the courts' analyses of this case and pertinent precedents. (Cassar-FRC)
W82-01455

AVOYELLES SPORTSMEN'S LEAGUE V. ALEXANDER,
K. L. Rosenbaum.
Environmental Law, Vol 12, No 1, p 231-242, Fall, 1981. 66 Ref.

Descriptors: *Wetlands, *Judicial decisions, *Land clearing, Water pollution prevention, Dredging, Legal aspects, Clean Water Act, Water law, Avoyelles Sportsmen's League v. Alexander, Farming, Lake Long, *Louisiana, Bayous.

The court ruled that clearing trees and shrubs from 20,000 acres of bottomland hardwoods in the Natchitoches basin, Louisiana (Lake Long tract) for soybeans farming was a violation of the Clean Water Act. In Avoyelles Sportsmen's League v. Alexander, the June 1979 decision ruled that land clearing operations were point sources of pollution under section 301, that the activities did produce dredged or fill materials (the cleared vegetation), that section 404 exemptions for normal farming and silviculture activities did not apply, and that the clearing activities would alter drainage and circulation patterns of the waters. In March 1981 the court ruled that this tract was a part of the waters of the U. S. as defined in the Clean Water Act. Although this decision was strongly in favor of environmentalists, its effectiveness in preserving wetlands may be lessened by budget cuts, lack of enforcement, and recent rulings that denial of a section 404 permit can be interpreted as taking of property without just compensation. (Cassar-FRC)
W82-01456

THE WATER DECADE (1981-1990).
UNESCO Courier, Vol 34, No 2, p 11-15, February, 1981.

Descriptors: *Developing countries, *Water supply development, *Public health, International Drinking Water Supply and Sanitation Decade, United Nations, Planning, Costs, Rural areas, Waste disposal.

The International Drinking Water Supply and Sanitation Decade is a worldwide cooperative effort to provide clean water and sanitation for all by the year 1990. The 1975 data indicate that fewer than 500 million of the 2000 million people in developing countries (not including China) have adequate water and sanitation. About 80% of sickness and disease can be attributed to these inadequacies. Widely varying cost estimates have been proposed for implementing the Decade's goals. The costliest option, $600 billion 1978 dollars for 100% coverage, assumes that urban households will all have water taps and be connected to sewer systems, rural households, standpipes or handpumps and individual latrines. Using acceptable but less sophisticated, lower cost technology, an 80% coverage could be reached for $300 billion. Participants in the Decade will be governments of both developed and developing countries, industry, educational institutions, and United Nations agencies. (Cassar-FRC)
W82-01534

A WATER RIGHTS STRATEGY FOR MINING OPERATIONS IN THE WESTERN US,
J. C. Green.
Mining Engineering, Vol, 33, No 8, p 1220-1222, August, 1981. 1 Fig.

Descriptors: *Water rights, *Mineral industry, *Water law, Legal aspects, Consumptive use, Environmental effects, Colorado, Western United States.

Legal and engineering issues in mining water rights in the semi-arid West are discussed. Water rights can be transferred by drying up historically irrigated lands to develop a new industrial water supply in an over-appropriated basin. An augmentation plan allows a new use of water by compensating the river system with various resources, sometimes at other locations. Before a mine begins operation, the water rights in the area must be reviewed, and the possible impacts of the operation on ground and surface waters must be assessed. The amount of consumptive use is important. Water rights must often be acquired, and it may take from one to three years to complete the augmentation plan. Most of the examples in this article deal with policies of the state of Colorado, but the concepts and principles used in other western states are similar. Early planning of a water rights strategy is often crucial to the mine planning process. (Small-FRC)
W82-01587

COMPELLED SELF-INCRIMINATION AND THE FEDERAL WATER POLLUTION CONTROL ACT,
J. McVey.
Natural Resources Journal, Vol 21, No 3, p 599-606, July, 1981. 61 Ref.

Descriptors: *Water law, *Judicial decisions, *Oil spills, Legal aspects, Constitutional law, Regulations, Federal Water Pollution Control Act, United States v. Ward, Arkansas River basin.

Ward, lessor of an Oklahoma drilling facility, was assessed a $500 civil penalty by the Coast Guard upon reporting, as required under the Federal Water Pollution Control Act, an oil spill into a tributary of the Arkansas River. Ward claimed, and the Tenth Circuit Court of Appeals agreed, that the act of reporting the spill was self-incriminating under the Fifth Amendment. The majority opinion of the U.S. Supreme Court found that the proceedings for assessment of a civil penalty was not a criminal or quasi-criminal proceeding, and therefore the Fifth Amendment privilege could not be invoked. The dissenting opinion stated that the reporting requirement is a form of compelled self-incrimination. (Cassar-FRC)
W82-01600

6F. Nonstructural Alternatives

THE PROBLEMS OF NON-RETURN AND THE USE OF VALVES IN DRINKING WATER PROTECTION AGAINST WASTE WATER RETURN, APPLYING THE REGULATIONS IN FORCE,
For primary bibliographic entry see Field 5F.
W82-01142

PREFERENCES FOR ALLOCATING RIVER RECREATION USE,
Montana Univ., Missoula. School of Forestry.
For primary bibliographic entry see Field 6D.
W82-01181

SANITATION SERVICE MANAGEMENT IN FRANCE (LA GESTION DES SERVICES D'ASSAINISSEMENT EN FRANCE),
Ingenieurs a la Societe Lyonnaise des Eaux et de l'Eclairage, Paris (France).
B. Auclair, and J-F. Bost.
Aqua, No 2, p 17-19, 21, 1981. 4 Fig.

Descriptors: *Wastewater treatment, *Maintenance, *France, Water treatment facilities, Management, Planning, Decision making, *Water pollution control.

An economic incentives program was instituted in an effort to curb water pollution in France. Highly effective municipal and industrial purification plants and sewerage systems have since been developed. Capital expenditures for maintaining the operation come from taxation and from fees charged directly to the user, based either on his water consumption or on the quantities of pollutants discharged. Organization and maintenance operations are conducted by the people or districts served by the facilities or can be handled through a firm of specialists on a contract basis. La Lyonnaise des Eaux handles cleansing services for some 600 townships throughout France. Different operation and maintenance problems are posed by each community, naturally influenced by the specific pollutants contained in the waste, Distinctions must be made between preventative maintenance, emergency services, and operation and upkeep, as all these activities have widely differing needs both in equipment and in human resources. The role of the operator must also take into account surveillance of connections with existing networks and ensure that discharges comply with prescribed standards. These tasks are more easily fulfilled by a company specializing in this area of operation and maintenance than by a municipal department. (Baker-FRC)
W82-01351

6G. Ecologic Impact Of Water Development

AN EMPIRICAL METHODOLOGY FOR ESTIMATING ENTRAINMENT LOSSES AT POWER PLANTS SITED ON ESTUARIES,
National Power Plant Team, Ann Arbor, MI.
J. Boreman, C. P. Goodyear, and S. W. Christensen.
Transactions of the American Fisheries Society, Vol 110, No 2, p 253-260, March, 1981. 3 Tab, 10 Ref.

Descriptors: *Entrainment, *Larvae, *Powerplants, *Estuaries, Fish, Shellfish, Eggs, Juvenile growth stage, Aquatic animals, Cooling water, Electric powerplants, Mortality, *Model studies, Mathematical equations, Potomac River, Rivers, Bass, Spawning, Forecasting, Planning, Nuclear powerplants, Potomac River estuary, *Douglas Point Nuclear Plant.

The Empirical Transport Model is a generalized mathematical equation for estimating the conditional entrainment mortality rate of aquatic organisms (especially fish and shellfish) due to water withdrawal from an estuary by one or more powerplants. The model is based on empirically derived age-, time-, and space-variant entrainment susceptibility data. There are two forms of the equation: the single-cohort approach (entrainable organisms are placed in the water body at the same time, e.g., by spawning over a short time interval) and the multiple-cohort approach (entrainable organisms introduced into the water body over an extended period). Model application requires data on water body morphometry, powerplant flow rates, probability of entrainment survival, and the duration, distribution, and abundance of entrainable age groups. The model was used to estimate the entrainment mortality of early stages of striped bass for the proposed Douglas Point Nuclear Plant on the Potomac River. Mortality rates obtained were 0.142% for eggs, 0.234% for yolk-sac larvae, 0.22% for fin-fold larvae, and total rate through the fin-fold stage, 0.398%. (Cassar-FRC)
W82-01173

ENTRAINMENT AND IMPINGEMENT IN POWER PLANT COOLING SYSTEMS,
Electric Power Research Inst., Palo Alto, CA.
W. Chow, I. P. Murarka, and R. W. Brocksen.
Journal of the Water Pollution Control Federation (Literature Review Issue), Vol 53, No 6, p 965-973, June, 1981. 143 Ref.

Descriptors: *Powerplants, *Aquatic life, Plankton, Hydroelectric plants, Electric powerplants, Cooling, Design considerations, Entrainment, Fish, *Cooling water, *Ecological effects.

Current research is reviewed on developments to define and control the characteristics of cooling water from the biological as well as the engineering standpoint. The biological view deals with advances in ecological concerns and findings on entrainment and impingement at power plants. Plant design aspects deal with advances in engineering designs to meet biological criteria. Entrainment mortalities to eggs larvae and small fish directly affect fish communities. Whether irreversible damage is done through impingement and entrainment is still being debated. Counts and estimates of fish losses are carried out at most cooling water intake locations. Findings of numerous studies in this field suggest that entrainment and impingement of organisms depends to a large extent on the schooling behavior of fish, including fish migrations. Entrainment of eggs and larvae occurred only during periods when the particular species was spawning and hatching. To assess the impacts and make a biological evaluation of the significance of entrainment and impingement mortality, it is necessary to have an accurate estimate of the fish population being impacted. The population level modeling approach is frequently employed to assess the fraction of a given population suffering mortality losses from entrainment and impingement. Plant design aspects considered include the intake structure design, offshore studies on fish mortality, use of barriers and screens, and collection, removal and return systems. (Baker-FRC)
W82-01276

HOLLAND'S EASTERN SCHELDT ESTUARY BARRIER SCHEME: SOME ECOLOGICAL CONSIDERATIONS,
Shell Internationale Research Maatshcappij N.V., The Hague (Netherlands). Group Toxicology Div.
For primary bibliographic entry see Field 2L.
W82-01375

PHYTOPLANKTON OF FOUR RIVERS, THE TYNE, WEAR, TEES AND SWALE,
Durham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2E.
W82-01376

ECOLOGY OF LARVAL FISHES IN LAKE OAHE, SOUTH DAKOTA,
Fish and Wildlife Service, Pierre, SD. North Central Reservoir Investigations.
W. R. Nelson.
Technical Papers of the U.S. Fish and Wildlife Service, No 101, 1980. 20 p, 7 Fig, 20 Tab, 29 Ref.

Descriptors: *Reservoirs, *Spawning, *Larval growth stage, *Aquatic habitats, *Water level fluctuations, *Fish, Reservoir operation, Fish food, Vegetation, Flooding, Shores, Ecology, Lake Oahe, *South Dakota.

In reservoir environments, which are less stable than those of natural lakes, characteristics such as water level fluctuation, shoreline erosion, and sedimentation often have profound effects on fish reproduction. Before existing water management programs are altered, the spawning and nursery area requirements for the predominant species must be understood. The time and location of spawning, food of larvae, and habitats used as nursery areas by young of the year fishes were studied from 1972 to 1975 in South Dakota waters of Lake Oahe, a main stem Missouri River reservoir. Sampling locations were in the tributary rivers and their embayments. The most heavily used spawning areas were in the rivers, which were the exclusive spawning ground for five fishes (goldeneye, walleye, sauger, white sucker, and minnows), and the major spawning ground of three others (white bass, buffalo, and carp). The upper reaches of the embayments were the preferred spawning locations of crappies and the preferred nursery areas of most young fishes. The lower reaches were the primary spawning grounds of yellow perch, burbot, shiners and darters. Year-class strength of river-spawning species was primarily dependent on above average water levels, which inundated terrestrial vegetation to provide a substrate for egg deposition and cover for larvae. Preserving adequate streamflow and enhancing reservoir shoreline areas by managing water levels, seeding vegetation, and eliminating grazing alongshore would probably ensure adequate reproduction of most species. (Moore-SRC)
W82-01444

7. RESOURCES DATA

7A. Network Design

REGIONALIZATION OF THE UPPER GREAT LAKES WITH RESPECT TO SURVEILLANCE EUTROPHICATION DATA,
Canada Centre for Inland Waters, Burlington (Ontario).
R. E. Kwiatkowski.
Journal of Great Lakes Reserch, Vol 6, No 1, p 38-46, 1980. 3 Fig, 3 Tab, 22 Ref.

Descriptors: *Monitoring, *Great Lakes, *Regional analysis, Lakes, Water quality, Water temperature, Chlorides, Nutrients, Lake Superior, Lake Huron, Sampling, *Eutrophication, International Joint Commission.

Lake Superior, Lake Huron, and the Georgian Bay-North Channel were divided into regions using a regression model developed by El-Shaarawi and Kwiatkowski (1977). Water quality parameters considered were: chloride, temperature, nitrate-nitrite, silica, total P, and chlorophyll a. The zones obtained in this study were similar to those proposed by the International Joint Commission for Lake Huron and the North Channel-Georgian Bay. However, results for Lake Superior indicate fewer zones than previously designated. Water temperature and chloride (from road salt) appeared to be the most reliable parameters for delineating zones. Inputs and currents were important factors in the size and shape of the regions. These studies are a step toward establishing a cost effective surveillance program for the Great Lakes by reducing the frequency of whole-lake surveys. (Cassar-FRC)
W82-01150

NEARSHORE SPATIAL DISTRIBUTION OF FISHES IN GILL NET SAMPLES, CAYUGA LAKE, NEW YORK,
Department of Energy, Pittsburgh, PA. Pittsburgh Energy Technology Center.
M. D. Dahlberg.
Journal of Great Lakes Research, Vol 7, No 1, p 7-14, 1981. 5 Fig, 1 Tab, 14 Ref.

Descriptors: *Fish populations, *Spatial distribution, Lakes, Seasonal variation, *Cayuga Lake, *New York, Temperature effects, Distribution, Trout, Northern pike, Bass, White sucker, Alewife, Yellow perch, Carp.

Nylon gill nets were set for 24 hr at monthly intervals at a proposed sampling site at Cayuga Station during December 1975 through December 1976. Gill nets were set on the bottom, and at the surface, middle and bottom layers. Water temperature during testing ranged from about 2 to about 22 degrees C at the surface, and from 2 to 13.6 degrees C at the 100 ft depth. Dissolved oxygen was at or near saturation in all weekly observations. The findings indicated that temperature was the most important factor in controlling the depth distribution of fish in Lake Cayuga. Warmwater species such as alewife, northern pike, spottail shiner, trout-perch and yellow perch concentrated in inshore and surface waters during the summer. Coldwater species such as rainbow smelt and lake trout concentrated in hypolimnetic waters during the summer. A limited number of Atlantic salmon were captured, at a maximum temperature of 13.9 degrees C. A direct relationship was noted between catch size and water temperature for yellow perch, alewife, and three other species which were captured in small numbers. The effect of water temperature on fish activity appears to be the primary factor in the seasonal vulnerability to the passive netting, at least for those species which are present year round in this study area. (Baker-FRC)
W82-01195

LIMNETIC LARVAL FISH OF THE MAUMEE AND SANDUSKY RIVER ESTUARIES,
Ohio State Univ., Put-in-Bay. Center for Lake Erie Area Research.
C. L. Cooper, W. C. Bartholomew, C. E. Herdendorf, J. M. Reutter, and F. L. Snyder.
Journal of Great Lakes Research, Vol 7, No 1, p 51-54, 1981. 2 Tab, 13 Ref.

Descriptors: *Estuaries, *Fish populations, Rivers, *Maumee River, *Sandusky River, Fish, Lake Erie basin, *Ohio.

A series of studies conducted in the Maumee River and Sandusky River estuaries on Lake Erie between 1975 and 1977 is summarized. The Maumee River study area encompassed a 14 sq km zone extending from the river mouth to the riffles above the head the estuary at Perrysburg, Ohio. The Sandusky River study area encompassed a 2 sq km zone extending from the river mouth at the head of Sandusky Bay to the upper limit of the estuary at the Fremont, Ohio, riffle, a distance of 24.9 km. Collections were made during daylight hours with conventional plankton nets. A limited number of samples were taken at night. A total of 17 taxa of larval fish was reported from the Maumee River estuary oer the three year sampling period. Greater carp larvae densities were indicated in the littoral areas and may have resulted in an overall underestimate of their abundance in the study areas. During periods of high densities, more larval gizzard shad and white bass were found in sheltered low flow portions than in the mid-channel portion of the midestuary sampling location. The predominant number of rainbow smelt and yellow perch larvae were collected at the Maumee River mouth location. Only limited numbers were collected farther upstream, and neither species was collected in the Sandusky River estuary. The study indicated a patchy, or nonrandom, distribution of walleye eggs, while larvae were randomly distrib-

uted. Overall, larval walleye densities decreased from relatively high densities upstream to relatively low densities downstream. (Baker-FRC)
W82-01197

REGIONAL FLOOD FREQUENCY ESTIMATION AND NETWORK DESIGN,
Princeton Univ., NJ. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W82-01294

WATER-QUALITY MONITORING: A GLOBAL APPROACH,
United Nations Environment Program, Geneva (Switzerland). Regional Seas Programme Activity Center.
R. Helmer.
Nature and Resources, Vol 17, No 1, p 7-13, January-March, 1981. 2 Fig.

Descriptors: *Monitoring, *Water analysis, *Global Environmental Monitoring System, Water quality, World Health Organization, International commissions, Water pollution, Network design.

The Global Environmental Monitoring System includes a World Health Organization project on Global Water Quality Monitoring (GEMS/WATER) established in 1976 with the following purposes: to strengthen existing water monitoring systems and establish new ones, to define and improve the validity and comparability of water quality data within and among member states, and to assess the incidence and long term trends of water pollution by certain persistent, hazardous substances. The ultimate goal is 1200 monitoring stations. To date, 388 have been identified in 62 countries: 227 on rivers, 74 on lakes, and 87 in aquifers. Data is routinely produced from 87 of the 236 recently-activated stations. Three categories of parameters have been established: basic (pH, dissolved oxygen, etc.), optional (total organic carbon, phytoplankton, etc.), and globally significant (heavy metals, pesticides, etc.). A concern for the immediate future is analytical quality control. (Cassar-FRC)
W82-01339

IMMEDIATE DETECTION OF HETEROGENEITIES IN CONTINUOUS MULTIVARIATE, OCEANOGRAPHIC RECORDINGS. APPLICATION TO TIME SERIES ANALYSIS OF CHANGES IN THE BAY OF VILLEFRANCHE SUR MER,
Biochimie Marine, Villefranche-sur-Mer (France). Station Zoologique.
F. Ibanez.
Limnology and Oceanography, Vol 26, No 2, p 336-349, March, 1981. 11 Fig, 3 Tab, 16 Ref.

Descriptors: *Sampling, *Multivariate analysis, *Heterogeneity, Time series analysis, Oceanography, Salinity, Monitoring, Water quality, Villefranche sur Mer, France, *Marine environment.

This paper presents an index that can be used in water sampling aboard ship to immediately detect discontinuities in continuously monitored, multivariate recordings of many physical and chemical variables. At every sampling point, the generalized distance is computed between the new multivariate observation and the centroid of the n previously recorded observations. These n points form a window, whose width determines the sensitivity of the index. By its mathematical formulation the distance takes into account the variations in range of the variables and their correlations. The validity of the index was first tested on simulated series into which different types of changes were arbitrarily introduced. The index is applied to a 4-year temperature and salinity series of weekly observations at a station in the bay of Villefranche sur Mer, France. (Cassar-FRC)
W82-01393

MAPPING CONTAMINATED SOIL PLUMES BY KRIGING,
Resources Management Associates, Lafayette, CA.
For primary bibliographic entry see Field 5G.
W82-01423

METHODS FOR GENERATING ALTERNATIVE SOLUTIONS TO WATER RESOURCES PLANNING PROBLEMS,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W82-01449

GENERATING ALTERNATIVE SOLUTIONS FOR DYNAMIC PROGRAMMING MODELS OF WATER RESOURCES PROBLEMS,
Illinois Univ. at Urbana-Champaign. Dept. of Landscape Architecture.
For primary bibliographic entry see Field 6A.
W82-01450

A ONE-DIMENSIONAL, FINITE ELEMENT SALT WATER INTRUSION MODEL,
Guam Univ., Agana. Water Resources Research Center.
D. N. Contractor.
Technical Report No 20, February, 1981. 20 p, 9 Fig, 10 Ref, 4 Append.

Descriptors: *Coastal aquifers, *Model studies, Mathematical models, Computer models, *Aquifer management, Seawater, Fortran, Saline water, Aquifer characteristics, Model testing, Prediction, Computers, Computer programs, Saline water intrusion.

Groundwater resources near the coastline and on islands should be managed in such a way that salt water intrusion into an aquifer does not jeopardize the quality of the water resource. Management of the salt water intrusion includes knowing the location of the wedge and predicting its response to changes in aquifer recharge and pumpage so that its future location can be controlled. A model is needed to make these predictions. The model may be analytical in nature for simple geometries, or numerical for more complicated aquifers. This report describes a one-dimensional, finite element salt water intrusion model, which can be very useful in understanding local features of an extensive aquifer system. A one-dimensional model can be an appropriate tool when first-cut results are necessary in a limited time. Two-dimensional models can be used to provide one-dimensional results, but only by using twice the number of nodes used in a one-dimensional model. Two-dimensional models should be used whenever the necessary data, computer facilities, and budget are available. A one-dimensional model's advantages are its simplicity, low cost of data aquisition, low computer time, and low total cost, as well as its versatility. Confined and unconfined aquifers can be handled, and time-dependent situations can be taken into account. In addition, non-homogeneities can be specified in the longitudinal direction. The computer program was written in Fortran. The nodes are numbered consecutively from left to right and the elements are numbered so that they are the same as the node number at the left-hand end of the element. A pump can be located at any node in the system. (Garrison-Omniplan)
W82-01452

COMPATIBILITY OF CANADIAN SNOWFALL AND SNOW COVER DATA,
Atmospheric Environment Service, Downsview (Ontario).
For primary bibliographic entry see Field 2C.
W82-01466

7B. Data Acquisition

FIXED ENDPOINT ALKALINITY DETERMINATION,
California Univ., Berkeley, Sanitary Engineering Research Lab.
F. Pearson.
Journal of the Water Pollution Control Federation, Vol 53, No 7, p 1243-1252, July, 1981. 4 Fig, 3 Tab, 7 Ref.

Descriptors: *Water analysis, *Alkalinity, *Acidity, Chemical properties, Chemical analysis, Volumetric analysis, Water quality, Laboratory tests, Analytical techniques, *Hydrogen ion concentration.

A theoretically developed procedure for alkalinity determination is proposed which offers the advantage over existing methods of requiring less analytical manipulation of the sample when both alkalinity and acidity are to be determined. It also has the ability to take into account the contribution to alkalinity and/or acidity by noncarbonate weak electrolytes which cannot be accomplished by existing methods without determining the entire titration curve. The theoretical development of the procedure is presented, and examples are given of the use of the first two equations. Also, experiments to test the validity of the procedure are summarized. Titrations to pH 4.5 and 8.3 can be used to calculate alkalinity and acidity values to equivalence endpoints. Manual titrations are performed rapidly, and automated determination of alkalinity or acidity is feasible with the new system. The validity of the procedure was confirmed for a limited range of conditions, and anomalous results were found to occur in some waters such as those of high ionic strength. More verification testing is required before the procedure can be adopted unequivocally for an unknown water type. (Small-FRC)
W82-01187

EFFECT OF GRAIN SIZE AND SNOWPACK WATER EQUIVALENCE ON VISIBLE AND NEAR-INFRARED SATELLITE OBSERVATIONS OF SNOW,
California Univ., Santa Barbara. Dept. of Geography.
J. Dozier, S. R. Schneider, and D. F. McGinnis, Jr.
Water Resources Research, Vol 17, No 4, p 1213-1221, August, 1981. 10 Fig, 1 Tab, 24 Ref.

Descriptors: *Snow cover, *Albedo, *Satellite technology, Remote sensing, Snow surveys, Water content, *Snowmelt, Snow water equivalence, Particle size, Snowpack, Wavelengths.

A model for spectral snow albedo by Wiscombe and Warren shows that visible reflectance is sensitive to snow water equivalence and contamination by aerosols, but near-infrared reflectance is sensitive to grain size and not to other variables. Therefore, satellite radiometric data can be used to infer snow water equivalence and snow grain size. When grain size is large (500-1000 micrometers), visible wavelengths may also estimate snow water equivalence. The TIROS-N series satellites' infrared channel is not in the range most sensitive to grain size. A shift of channel near infrared wavelengths from 0.7-1.0 micrometers to 1.0-1.2 micrometers would improve sensitivity to grain size and decrease sensitivity to snow water equivalence. Satellite data collected on April 12, and 27, 1980, over Lake Winnipeg, Manitoba, and over 3 lakes in central Saskatchewan were compared with ground observations at these locations. (Cassar-FRC)
W82-01311

AUTOMATIC CLASS-A PAN-FILLING SYSTEM,
Science and Education Administration, Boise, ID. Northwest Watershed Research Center.
M. D. Burgess, and C. L. Hanson.
Journal of Hydrology, Vol 50, No 1-3, p 389-392, March, 1981. 1 Fig, 1 Tab.

Descriptors: *Evaporation pans, *Control systems, *Automation, Pan evaporation, Electrical equipment, Evaporation rate.

The National Weather Service Class-A pan is the standard evaporation measuring device in the United States and several other countries. A low-cost battery-operated system to automatically fill Class A evaporation pans from stored water was developed using integrated circuit technology. The system is suitable for use in remote areas where batteries are used for power to maintain the water level between 5.08 and 7.62 cm below the top of the pan. Trials at four locations near Boise, Idaho, in 1979 revealed no electronics or battery prob-

lems. The system can operate for 6 months on a 20-A-hour low self-discharge battery. (Cassar-FRC)
W82-01326

SITES OF RIVER-DERIVED SEDIMENTATION IN THE OCEAN,
Delaware Univ., Newark. Coll. of Marine Studies.
R. J. Gibbs.
Geology, Vol 9, No 2, p 77-80, February, 1981. 3 Fig, 1 Tab, 11 Ref.

Descriptors: *Sediment deposition, *Rivers, *Remote sensing, Mississippi River, Colorado River, Delaware Bay, Chesapeake Bay, Deltas, Sea level, Alluvial fans, Amazon River.

Landsat satellite imagery (Band 4) was used to identify the seaward boundary of turbid waters for 22 of the world's large rivers. At the Amazon River mouth, surface water samples for suspended matter analysis were collected at the time the imagery was made. It was concluded that rivers are depositing suspended sediments on the shelf areas or in estuaries, not on the vast submarine fans created during a lower sea level era. Assuming no changes in the present rates of sediment deposition, the calculated times to fill the present sediment areas range from 2630-3406 years for the Ganges-Brahmaputra system to 936,000 - 1.2 million for the Yenisei-Ob system. The higher values account for compaction and subsidence. Values for some U. S. rivers were (in years): Mississippi, 79,242-102,619; Colorado, 8,515-11,027; Delaware Bay, 80,772-104,600; Chesapeake Bay, 109-963-142,403; and the Delaware Shelf, which includes the Chesapeake and Delaware Bays, 464,538-601,577. Only the Ganges, Yellow, and Indus Rivers are likely to fill their shelves before significant sea level changes occur. (Cassar-FRC)
W82-01332

AN ALL-TEFLON BAILER AND AN AIR-DRIVEN PUMP FOR EVACUATING SMALL-DIAMETER GROUND-WATER WELLS,
Camp, Dresser and McKee, Inc., Milwaukee, WI. Environmental Sciences Div.
D. F. Buss, and K. E. Bandt.
Ground Water, Vol 19, No 4, p 429-431, July/August, 1981. 1 Fig, 3 Ref.

Descriptors: *Well data, *Water sampling, *Pumps, Sampling, Groundwater, Monitoring, Water quality, Small-diameter wells.

Sampling of small diameter wells (2 inches) was facilitated by use of an all-teflon bailer and an air-driven pump with a teflon ball. This apparatus, which can purge 18.5 liters from a 2 inch diameter well in 6-8 minutes (vs. raising and lowering a 0.5 liter conventional bailer 37 times), minimizes contamination of the sample and is very easy to disassemble and clean. The pump was effective to 100 ft, the greatest depth tested. Construction materials, readily available from hardware and plastic piping supply stores, cost less than $25, excluding the tygon tubing. (Cassar-FRC)
W82-01333

REMOTE SENSING OF SOIL MOISTURE CONTENT OVER BARE FIELD AT 1.4 GHZ FREQUENCY,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
J. R. Wang, and B. J. Choudhury.
Journal of Geophysical Research, Vol 86, No C6, p 5277-5282, June, 1981. 6 Fig, 18 Ref.

Descriptors: *Soil moisture, *Microwaves, *Radiometery, Model studies, Moisture content, *Remote sensing.

An algorithm for estimating moisture content of a bare soil from the observed brightness temperatures at 1.4 GHz is based on a radiative transfer model calculation (Wilheit, 1978). Some modifications are made to account for the effects of surface roughness. Besides the brightness temperatures, additional inputs required are effective soil thermodynamic temperature, precise relation between moisture content and the smooth field brightness temperature, and two parameters related to surface roughness. The algorithm is applied to two series of radiometer observations, truck mounted and airborne. The estimated moisture contents compare favorably to those observed in the top 2 cm layer of soil. (Cassar-FRC)
W82-01345

WATER FROST AND ICE: THE NEAR-INFRARED SPECTRAL REFLECTANCE 0.65-2.5 MICRONS,
Hawaii Univ., Honolulu. Inst. for Astronomy.
For primary bibliographic entry see Field 2C.
W82-01346

MULTIFREQUENCY RADIOMETER DETECTION OF SUBMARINE FRESHWATER SOURCES ALONG THE PUERTO RICAN COASTLINE,
National Aeronautics and Space Administration, Hampton, VA. Langley Research Center.
For primary bibliographic entry see Field 3B.
W82-01349

SITE ASSESSMENT: IMPROVING CONFIDENCE LEVELS WITH SURFACE REMOTE SENSING,
Technos Inc., Miami, Florida.
For primary bibliographic entry see Field 5G.
W82-01422

THE INFERENCE OF GATE CONVECTIVE RAINFALL FROM SMS-1 IMAGERY,
National Hurricane and Experimental Meteorology Lab., Coral Gables, FL.
W. L. Woodley, C. G. Griffith, J. S. Griffin, and S. C. Stromatt.
Journal of Applied Meteorology, Vol 19, No 4, p 388-408, April, 1980. 19 Fig, 7 Tab, 7 Ref.

Descriptors: *Rainfall distribution, *Remote sensing, *Satellite technology, Measuring instruments, Diurnal distribution, Temperature effects, Precipitation, Rainfall area, Rainstorms, *Atlantic Ocean, *Africa.

An automated technique making use of geosynchronous, infrared satellite imagery and a set of empirical relationships has been employed to estimate rainfall in the eastern Atlantic and western Africa during the Global Atmospheric Research Program's Atlantic Tropical Experiment (GATE). The satellite-derived rain estimates are low for the Atlantic and high for Africa when compared with radar and raingage estimates of precipitation. The daily satellite-derived maps of rainfall were generally similar to the radar products, but have lower point maxima. This difference is primarily caused by the method of rainfall apportionment and secondarily by the differences in resolution of the radar and satellite. Based on satellite-derived rain estimates, the rainfall in the eastern Atlantic appears to be of lesser magnitude, but about equal in coverage to the western Pacific. Most of the significant convective activity occurs in the Intertropical Convergence Zone (ITCZ), stretching westsouthwest from Africa. Rain maxima showed a close association with the sea surface temperature. A disproportionate amount of rainfall occurs over the water areas during the day and over the land areas during the late evening. The diurnal rainfall studies suggest a midday maximum of rainfall over the water areas and a late evening maximum over Africa and the northern part of South America. The center of action for cloud formation, merger and dissipation, and the area of maximum rainfall occur along the southwest African coast near 11 degrees N. (Baker-FRC)
W82-01519

ICE NUCLEUS CONCENTRATIONS MEASURED DURING THE 1975 FLORIDA AREA CUMULUS EXPERIMENT (FACE),
MITRE Corp., McLean, VA.
J. Wisniewski, and G. Langer.
Journal of Applied Meteorology, Vol 19, No 6, p 676-682, June, 1980. 5 Fig, 16 Ref.

Descriptors: *Ice, *Cloud seeding, Weather modification, Artificial precipitation, Tropical regions, Florida, Measuring instruments, Remote sensing, Nucleation.

Ice nuclei concentrations over Florida were obtained by two techniques. First, about 390 membrane samples were collected using a sequential membrane filter system. The second method called for continuous ice nuclei concentrations to be obtained by the NCAR acoustical ice nucleus counter. The technique using collection membranes gave concentrations of ice nuclei about two orders of magnitude lower than those obtained by the NCAR acoustical counter, with both sets of samples obtained at identical time periods. It is recommended that the membrane technique should not be used alone in maritime studies. The ice nuclei concentrations obtained with the NCAR acoustical counter were shown to naturally increase by a factor of 2 to 3 during the course of normal afternoon convective activity; these factors are reasonable compared to observed glacation. These increases are probably due to turbulence within the storm areas stirring up soil particles from the ground and increasing ice nuclei concentrations or to ice nuclei being released by evaporation of small precipitation particles between the cloud base and the surface or in the downdraft. In certain cloud seeding experiments, these natural ice nuclei increases may make seeding less effective. It is suggested that a spectrum of ice nuclei concentrations be obtained to measure nucleation activities at several specified temperatures. This can be achieved by varying the cloud chamber temperature and glycol gravity of the NCAR counter. (Baker-FRC)
W82-01522

AN IMPROVED METHOD FOR OBTAINING THE WATER CONTENT VALUES OF ICE HYDROMETEORS FROM AIRCRAFT AND RADAR DATA,
Air Force Geophysics Lab., Hanscom AFB, MA.
V. G. Plank, R. O. Berthel, and A. A. Barnes, Jr.
Journal of Applied Meteorology, Vol 19, No 11, p 1293-1299, November, 1980. 5 Fig, 3 Ref.

Descriptors: *Snow, Rain, *Hydrometeorology, *Meteorological data collection, Data collections, *Ice, Clouds, Precipitation, Aircraft, Radar, Weather forecasting, *Water content.

The spectral parameter k (equal to M divided by the square root of Z) computed from aircraft size distribution for single samples of ice hydrometeors (snow and ice crystals) is a much more stable parameter, under L (physical size) and D (equivalent melted diameter) conversion assumption, than is either spectral M (spectral liquid water content) or spectral Z (spectral radar reflectivity factor). Using k rather than Z sub R, more accuracy is possible in correlating multiple-sample aircraft data with simultaneously acquired, independent radar measurements of A and Z sub R. Spectral k is also useful as a reference parameter to differentiate between cloud conditions on different days or between different clouds, and applies also to water hydrometeors (rain). The k value appears to be primarily dependent on total number of hydrometeors and secondarily dependent on the form factor of the distribution (most observed distributions being quasi-exponential). (Cassar-FRC)
W82-01523

A BALLOONBORNE INSTRUMENT FOR THE MEASUREMENT OF VERTICAL PROFILES OF SUPERCOOLED LIQUID WATER CONCENTRATION,
Utah Water Research Lab., Logan.
G. E. Hill, and D. S. Woffinden.
Journal of Applied Meteorology, Vol 19, No 11, p 1285-1292, November, 1980. 8 Fig, 1 Tab, 8 Ref.

Descriptors: *Clouds, *Supercooling, *Remote sensing, Measuring instruments, *Water content.

Vertical profiles of the concentration of supercooled liquid water in clouds were measured by a vibrating wire placed in the humidity duct of a standard U.S. rawinsonde. As ice collects on the

wire, the natural frequency of vibration varies. The supercooled water concentrations are obtained from this wire frequency measurement and the air velocity relative to the instrument. Vibration frequency may be monitored on the ground for remote readings. Calibration of the frequency change vs. ice mass accumulation is done both theoretically and experimentally in a wind tunnel in the presence of supercooled water. For further verification, paint sprayed on the upwind side of the wire was used to simulate ice mass. The method is illustrated by a description of sounding at 0010 GMT February 8, 1980, in a stratocumulus deck above Richmond, Utah. In this case the cloud thickness was estimated at 350 meters with a 409 meter maximum. The supercooled liquid water concentration was 0.1 g per cu meter. This method is well suited for studies of winter orographic clouds. (Cassar-FRC)
W82-01524

EXPERIMENTAL VERIFICATION OF THE LINEAR RELATIONSHIP BETWEEN IR EXTINCTION AND LIQUID WATER CONTENT OF CLOUDS,
Nevada Univ. System, Reno. Desert Research Inst.
A. W. Gertler, and R. L. Steele.
Journal of Applied Meteorology, Vol 19, No 11, p 1314-1317, November, 1980. 3 Fig, 6 Ref.

Descriptors: *Clouds, *Remote sensing, *Lasers, Fog, Meteorological data collection, *Water content.

A CO2 laser extinction transmissometer was used to measure the IR extinction of clouds and fogs. Using an established linear relationship (based on the Chylek approximation to the Mie theory) between extinction and liquid water content, the liquid water content of clouds of varying droplet size (2.3-8.7 micrometers) and concentrations (up to 3 g per cu meter) have been determined. The values agreed well (correlation coefficient 0.98) with liquid water contents derived from a simultaneous cloud collection. There was little difference between monodisperse and polydisperse droplets. This method is adaptable for airborne measurements. (Cassar-FRC)
W82-01525

A COMPARISON OF TWO SATELLITE RAINFALL ESTIMATES FOR GATE,
Hawaii Univ., Honolulu. Joint Inst. for Marine and Atmospheric Research.
O. Garcia.
Journal of Applied Meteorology, Vol 20, No 4, p 430-438, April, 1981. 11 Fig, 4 Tab, 6 Ref.

Descriptors: *Rainfall, *Remote sensing, *Satellite technology, Precipitation, Sensors, Estimating, Tropical regions, Africa, Comparison studies.

Rainfall estimate comparisons derived from two satellite rainfall estimation techniques for the GATE experiment are made. One technique, the Kilonsky-Ramage technique, uses polar orbiting satellites for 1 degree resolution rainfall estimates over the tropics. The second technique used, the Griffith-Woodley technique, uses geostationary satellite data to generate much higher resolution estimates. The two techniques showed good correspondence between the A scale isohyetal patterns and rainfall volumes estimated for periods ranging from 1 to 80 days. Over African and nearby ocean areas the largest discrepancies were noted. In these cases the Griffith-Woodley estimates were higher. When only oceanic points are compared, correlation coefficients between the two estimates are higher, ranging up to 0.92 for the entire GATE period. Including continental areas of the A scale brings about a lowering of the correlation coefficients, reaching 0.66 for phase 2. Large discrepancies over Africa and oceanic areas are associated with a nocturnal peak of rainfall not detected by the daytime passes of the polar orbiting satellite used in the Kilonsky-Ramage calculations. It is concluded that the Kilonsky-Ramage technique can provide a low cost and fairly reliable estimate of monthly rainfall over the tropical oceans. This technique can also identify on a daily basis areas of significant rainfall and can estimate daily rainfall volumes over large areas. (Baker-FRC)
W82-01533

DETERMINATION OF MOISTURE FROM NOAA POLAR ORBITING SATELLITE SOUNDING RADIANCES,
National Earth Satellite Service, Washington, DC.
For primary bibliographic entry see Field 2B.
W82-01535

APPLICATION OF AERIAL PHOTOGRAPHS AND SURFICIAL GEOLOGIC MAPS TO THE DETERMINATION OF SUITABILITY OF LAND FOR SEPTIC TANK SYSTEMS,
Federal Energy Regulatory Commission, Washington, DC.
S. D. Connors.
Bulletin of the Association of Engineering Geologists, Vol 17, No 3, p 153-162, Summer, 1980. 3 Fig, 2 Tab.

Descriptors: *Septic tanks, *Aerial photography, Wastewater treatment, Permeability, Bedrock, Water table, Geological formations, Photography, Glacial sediments, Remote sensing, Planning, Wyoming County, New York.

Aerial photographs, surficial geology, grain size analysis and permeability tests were used to determine the suitability of the area around the town of Arcade, Wyoming County, New York for septic tank systems. Based on topography and type of surficial deposits, the study area can be divided into three regions readily discernible on aerial photographs and topographic maps. These are: upland till area, wide valley areas and areas of glacial outwash deposits, and an undulating, hilly morainal area. Bedrock underlying the town of Arcade consists of Upper Devonian gray to black shales, gray siltstones and brown sandstone. Surficial deposits in the area consist of glacial till, outwash, ice contact deposits, lake deposits and recent alluvium. Four soil associations, based on the parent glacial material, are recognized in the town of Arcade. These are: Erie-Landford, developed on glacial till; Bath-Valois and Howard-Madrid, developed on contrasting glacial deposits; and Chenango-Howard-Castile, developed on glacial outwash deposits. Septic tank fields in the first association need careful design due to slow permeability, seasonal high water table and shallow depth to bedrock. The Chenango-Howard-Castile soils tend to provide good septic tank fields. Use of the Bath-Valois and Howard-Madrid associations requires careful investigation due to the extreme variability of physical properties within short distances and with depth. Laboratory testing indicated that soils in the town of Arcade were generally unsuited for septic tank systems. The best suited area occurs in the village of Arcade, which has a sewer system. The upland till area is considered the least favorable area. (Baker-FRC)
W82-01569

7C. Evaluation, Processing and Publication

ABUNDANCE OF ORGANIC COMPOUNDS IN WATER,
Illinois Environmental Protection Agency, Springfield.
For primary bibliographic entry see Field 5A.
W82-01162

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1980--VOLUME 1. ARKANSAS RIVER BASIN, RED RIVER BASIN, SABINE RIVER BASIN, NECHES RIVER BASIN, TRINITY RIVER BASIN AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-123670, Price codes: A99 ($42.00) in paper copy, A01 in microfiche. Geological Survey Water-Data Report TX-80-1, 1981. 595 p, 1 Fig.

Descriptors: *Hydrologic data, *Surface water, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Data collections, Sites, *Texas, Arkansas River basin, Red River basin, Sabine River basin, Neches River basin, Trinity River basin.

Surface-water data for the 1980 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (USGS)
W82-01201

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1980--VOLUME 2. SAN JACINTO RIVER BASIN, BRAZOS RIVER BASIN, SAN BERNARD RIVER BASIN AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-123464, Price codes: A21 in paper copy, A01 in microfiche. Geological Survey Water-Data Report TX-80-2, 1981. 472 p, 1 Fig.

Descriptors: *Hydrologic data, *Surface water, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Data collections, Sites, *Texas, San Jacinto River basin, Brazos River basin, San Bernard River basin.

Surface-water data for the 1980 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (USGS)
W82-01202

WATER RESOURCES DATA FOR TEXAS, WATER YEAR 1980--VOLUME 3. COLORADO RIVER BASIN, LAVACA RIVER BASIN, GUADALUPE RIVER BASIN, NUECES RIVER BASIN, RIO GRANDE BASIN AND INTERVENING COASTAL BASINS.
Geological Survey, Austin, TX. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-123472, Price codes: A25 in paper copy, A01 in microfiche. Geological Survey, Water-Data Report TX-80-3, 1981. 583 p, 1 Fig.

Descriptors: *Hydrologic data, *Surface water, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Data collections, Sites, *Texas, Colorado River basin, Lavaca River basin, Guadalupe River basin, Nueces River basin, Rio Grande basin.

Surface-water data for the 1980 water year for Texas are presented in three volumes, appropriately identified as to content by river basins. Data in each volume consist of records of stage, discharge, and water quality of streams and canals; and stage, contents, and water quality of lakes and reservoirs. Also included are crest-stage and flood-hydrograph partial-record stations, reconnaissance partial-record stations, and low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. Records for a few pertinent stations in bordering States are also included. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Texas. (USGS)
W82-01203

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1980--VOLUME 1. COLORADO RIVER BASIN, SOUTHERN GREAT BASIN FROM MEXICAN BORDER TO MONO LAKE BASIN, AND PACIFIC SLOPE BASINS FROM TIJUANA RIVER TO SANTA MARIA RIVER.
Geological Survey, Menlo Park, CA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-116997, Price codes: A20 in paper copy, A01 in microfiche. Geological Survey Water-Data Report CA-80-1, 1981. 451 p, 5 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *California, Colorado River basin, Southern Great Basin, Pacific slope basins.

Volume 1 of water resources data for the 1980 water year for California consists of records of stage, discharge, and water quality of streams; stage and contents in lake and reservoirs; and water levels in wells. This report contains discharge records for 174 gaging stations, stage and contents for 18 lakes and reservoirs, water quality for 51 stations and water levels for 165 observation wells. Also included are 9 crest-stage partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (USGS)
W82-01204

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1980--VOLUME 2. PACIFIC SLOPE BASINS FROM ARROYO GRANDE TO OREGON STATE LINE EXCEPT CENTRAL VALLEY.
Geological Survey, Menlo Park, CA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-122243, Price codes: A23 in paper copy, A01 in microfiche. Geological Survey Water-Data Report CA-80-2, 1981. 521 p, 3 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes Reservoir, Wells, Water level, Data collections, Sites, *California, Pacific slope basins.

Volume 2 of water resources data for the 1980 water year for California consists of records of stage, discharge, and water quality of streams and wells; stage, contents, and water quality in lakes and reservoirs; and water levels in wells. This report contains discharge records for 159 gaging stations, stage and contents for 19 lakes and reservoirs, water quality for 116 stations and 32 wells, and water levels for 85 observation wells. Also included are 4 crest-stage partial-record stations and 3 low-flow partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (USGS)
W82-01205

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1980--VOLUME 3. SOUTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM WALKER RIVER TO TRUCKEE RIVER.
Geological Survey, Menlo Park, CA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-117003, Price codes: A19 in paper copy, A01 in microfiche. Geological Survey Water-Data Report CA-80-3, 1981. 429 p, 12 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *California, Southern central valley basins, The Great Basin.

Volume 3 of water resources data for the 1980 water year for California consists of records of stage, discharge, gage-height, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; water levels and water quality of wells. This report contains discharge records for 185 gaging stations, stage and contents for 39 lakes and reservoirs, gage-height records for 2 lakes, water quality for 62 stations, and water levels for 56 observation wells. Also included are 11 crest-stage partial-record stations and one water-quality partial-record station. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (USGS)
W82-01206

WATER RESOURCES DATA FOR CALIFORNIA, WATER YEAR 1980--VOLUME 4. NORTHERN CENTRAL VALLEY BASINS AND THE GREAT BASIN FROM HONEY LAKE BASIN TO OREGON STATE LINE.
Geological Survey, Menlo Park, CA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-117011, Price codes: A20 in paper copy, A01 in microfiche. Geological Survey Water-Data Report CA-80-4, 1981. 451 p, 12 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *California, Northern central valley basins, The Great Basin, Sacramento River basin.

Volume 4 of the water resources data for the 1980 water year for California consists of records of stage, discharge, and water quality of streams; stage, contents, and water quality in lakes and reservoirs; and water levels in wells. This report contains discharge records for 199 gaging stations, stage and contents for 34 lakes and reservoirs, precipitation data for stations, water quality for stations, water levels for 54 observation wells and water quality for 26 wells. Also included are 16 crest-stage partial-record stations and 7 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as special investigations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in California. (USGS)
W82-01207

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1980 - VOLUME 1. HAWAII.
Geological Survey, Honolulu, HI. Water Resources Div.
Geological Survey Water-Data Report HI-80-1, 1981. 270 p, 15 Fig, 1 Tab.

Descriptors: *Hydrologic data, *Surface water, Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Hawaii.

Volume 1 of water resources data for the 1980 water year for Hawaii and other Pacific areas consist of records of stage, discharge, and water quality of streams; and water levels and water quality in wells and springs. This report contains discharge records for 109 gaging stations; water quality for 10 gaging stations, 103 partial-record flow stations, and 156 wells; and water levels for 22 observation wells. Also included are 109 crest-stage partial-record stations and 19 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, Federal, and other agencies in Hawaii. (USGS)
W82-01208

WATER RESOURCES DATA FOR HAWAII AND OTHER PACIFIC AREAS, WATER YEAR 1980 - VOLUME 2. TRUST TERRITORY OF THE PACIFIC ISLANDS, GUAM, AMERICAN SAMOA, AND NORTHERN MARIANA ISLANDS.
Geological Survey, Honolulu, HI. Water Resources Div.
Geological Survey Water-Data Report HI-80-2, 1981. 158 p, 16 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Hawaii, Mariana Islands, Carolina Islands, Samoa Islands.

Volume 2 of water resources data for the 1980 water year for other Pacific areas consist of records of stage, discharge, and water quality of streams; stage of a reservoir; and water levels in wells and springs. This report contains discharge records for 41 gaging stations, stage only record for 1 gaging station, water quality for 1 gaging station and 49 partial-record stations, water temperature for 23 gaging stations, water levels for 13 observation wells, tide level for 1 tide station, and 7 water level less tide level tables. Also included are 33 low-flow partial-record stations. Additional water data were collected at various sites, not part of the systematic data-collection program, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating Governments and Federal agencies in other Pacific areas. (USGS)
W82-01209

WATER RESOURCES DATA FOR SOUTH CAROLINA, WATER YEAR 1980.
Geological Survey, Columbia, SC. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-127127, Price codes: A15 in paper copy, A01 in microfiche. Geological Survey Water-Data Report SC-80-1, 1981. 319 p, 5 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *South Carolina.

Water resources data for the 1980 water year for South Carolina consist of records of stage, discharge, and water quality of streams; stage, contents, and water levels in wells. This report contains discharge records for 74 gaging stations, stage-only records for 10 gaging stations, stage and contents

for 11 lakes and reservoirs, water quality for 33 gaging stations, and water levels for 45 observation wells. Also included are 41 crest-stage partial-record stations. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in South Carolina. (USGS)
W82-01211

WATER RESOURCES DATA FOR PENNSYLVANIA, WATER YEAR 1980--VOLUME 2. SUSQUEHANNA AND POTOMAC RIVER BASINS.
Geological Survey, Harrisburg, PA. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-115908, Price codes: A16 in paper copy, A01 in microfiche. Geological Survey Water-Data Report PA-80-2, 1981. 353 p, 7 Fig.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Pennsylvania, Susquehanna River basin, Potomac River basin.

Water resources data for the 1980 water year for Pennsylvania consist of records of discharge and water quality of streams; contents of lakes and reservoirs; and water levels of ground-water wells. This volume contains records for water discharge at 100 stations, contents at 13 lakes and reservoirs, water quality at 35 gaging stations, and water levels at 25 observation wells. Also included are data for 21 crest-stage, 15 low-flow, and 129 water-quality partial-record stations. Additional water data were collected at various sites not involved in the systematic data-collection program and are published as miscellaneous measurements and analysis. These data together with the data in Volumes 1 and 3 represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State, local, and Federal agencies in Pennsylvania. (USGS)
W82-01212

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1980--VOLUME 1. HUDSON BAY BASIN, MISSOURI RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-127713, Price codes: A99 ($45.00) in paper copy, A01 in microfiche. Geological Survey Water-Data Report MT-80-1, 1981. 651 p, 9 Fig, 4 Tab.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Montana, Hudson Bay, Missouri River basin.

Water resources data for the 1980 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water levels in wells. Volume 1 of this report contains discharge records for 176 gaging stations, stage only records for 1 lake station, stage and contents for 6 lakes and reservoirs, water quality for 118 stations, and water lvels for 9 observation wells. Also included are 141 crest-stage partial-record stations and 23 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data-collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (USGS)
W82-01213

WATER RESOURCES DATA FOR MONTANA, WATER YEAR 1980--VOLUME 2. UPPER COLUMBIA RIVER BASIN.
Geological Survey, Helena, MT. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-127721, Price codes: A09 in paper copy, A01 in microfiche. Geological Survey Water-Data Report MT-80-2, 1981. 184 p, 6 Fig, 4 Tab.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Resevoirs, Wells, Water level, Data collections, Sites, *Montana, Columbia River basin.

Water resources data for the 1980 water year for Montana consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs; and water lvels in wells. Volume 2 of this report contains discharge records for 48 gaging stations, stage and contents for 3 lakes and reservoirs, water quality for 22 stations and 3 lakes, and water levels for 14 observation wells. Also included are 24 crest-stage partial-record stations and 20 smaller reservoirs. Additional water data were collected at various sites, not part of the systematic data-collection programs, and are published as miscellaneous measurements. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Montana. (USGS)
W82-01214

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1980--VOLUME 3A: SOUTHWEST FLORIDA SURFACE WATER.
Geological Survey, Tallahassee, FL. Water Resources Division.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-131186, Price codes: A25 in paper copy, A01 in microfiche. Geological Survey Water-Data Report FL-80-3A, 1981. 576 p, 15 Fig, 1 Tab, 16 Ref.

Descriptors: *Hydrologic data, *Surface water, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Data collections, Sites, *Florida, Southwest Florida.

Water resources data for the 1980 water year in Florida consist of continuous or daily discharge for 271 streams, periodic discharge for 47 streams, continuous or daily stage for 67 streams, periodic stage for 49 streams, peak discharge for 76 streams and peak stage for 23 streams; continuous or daily elevations for 75 lakes and periodic elevations for 128 lakes; continuous ground water levels for 483 wells, periodic ground water levels for 661 wells, and miscellaneous water level measurements for 2,807 wells; and quality of water data for 301 surface water sites and 842 wells. The surface-water data in this volume for southwest Florida includes continuous or daily discharge for 68 streams, periodic discharge for 24 streams, peak dicharge for 16 streams, continuous or daily stage for 18 streams and periodic stage for 9 streams; continuous elevations for 35 lakes and periodic elevations for 78 lakes; and quality of water for 100 surface water sites. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State and Federal agencies in Florida. (USGS)
W82-01215

WATER RESOURCES DATA FOR FLORIDA, WATER YEAR 1980--VOLUME 3B: SOUTHWEST FLORIDA GROUND WATER.
Geological Survey, Tallahassee, FL. Water Resources Div.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-131194, Price codes: A25 in paper copy, A01 in microfiche. Geological Survey Water-Data Report FL-80-3B, 1981. 560 p, 19 Fig, 1 Tab, 16 Ref.

Descriptors: *Hydrologic data, *Groundwater, *Water quality, Water analysis, Water temperature, Chemical analysis, Wells, Water level, Data collections, Sites, *Florida, Southwest Florida.

Water resources data for the 1980 water year in Florida consist of continuous or daily discharge for 271 streams, periodic discharge for 47 streams, continuous or daily stage for 67 streams, periodic stage for 49 streams, peak discharge for 76 streams and peak stage for 23 streams; continuous or daily elevations for 75 lakes and periodic elevations for 128 lakes; continuous ground water levels for 483 wells, periodic ground water levels for 661 wells, and miscellaneous water level measurements for 2,807 wells; and quality of water data for 301 surface water sites and 842 wells. The groundwater data in this volume for southwest Florida includes continuous ground water levels for 236 wells, periodic ground water levels for 250 wells, and miscellaneous water level measurements for 1119 wells; and quality of water for 242 wells. These data represent the National Water Data System records collected by the U.S. Geological Survey and cooperating local, State and Federal agencies in Florida. (USGS)
W82-01216

WATER RESOURCES DATA FOR COLORADO, WATER YEAR 1980--VOLUME 2. COLORADO RIVER BASIN ABOVE DOLORES RIVER.
Geological Survey, Lakewood, CO. Water Resources Div.
Geological Survey Water-Data Report CO-80-2, 1981. 387 p, 4 Fig, 4 Tab, 40 Ref.

Descriptors: *Hydrologic data, *Surface water, *Groundwater, *Water quality, Gaging stations, Streamflow, Flow rates, Sediment transport, Water analysis, Water temperature, Chemical analysis, Lakes, Reservoirs, Wells, Water level, Data collections, Sites, *Colorado, Colorado River basin.

Water-resources data for Colorado for the 1980 water year consist of records of stage, discharge, and water quality of streams; stage, contents, and water quality of lakes and reservoirs, and water levels and water quality of wells and springs. This report (Volumes 1, 2, and 3) contains discharge records for about 460 gaging stations, stage and contents of 22 lakes and reservoirs, 4 partial-record low-flow stations, 30 crest-stage partial-record stations, and 50 miscellaneous sites; water quality for 163 gaging stations and 300 miscellaneous sites; and water levels for 55 observation wells. A few pertinent stations in bordering States also are included. These data represent that part of the National Water Data System collected by the U.S. Geological Survey and cooperating State and Federal agencies in Colorado. (USGS)
W82-01217

8. ENGINEERING WORKS

8A. Structures

REDESIGN CONTROLS MANHOLE LEAKAGE,
For primary bibliographic entry see Field 8G.
W82-01237

RISK MODELS FOR FLOOD LEVEE DESIGN,
Nevada Univ. Systems, Reno. Dept. of Civil Engineering.
Y. K. Tung, and L. W. Mays.
Water Resources Research, Vol 17, No 4, p 833-841, August, 1981. 6 Fig, 5 Tab, 29 Ref.

Descriptors: *Levees, *Risks, *Flood protection, Safety, *Design criteria, Flood damage, Flood recurrence interval, Model studies, Hydraulic structures, Hydraulic engineering, Hydraulic models, Hydraulic design, Flood control.

Both hydrologic and hydraulic uncertainties are considered in development of risk models for overtopping in flood levee design. This is a refinement over conventional procedures, which consider only the hydrologic variables (such as flood flows)

and use a safety factor to account for all other uncertainties. Models systematically analyze hydrologic uncertainties (inherent, model, and parametric) and hydraulic uncertainties (model, construction and material, and flow operational conditions) and define the risk and reliability of overtopping. Both static and time dependent risk models are presented. Results show that the simple return period method can underestimate risk by 10-50%. It is best to use composite models for risk analysis because the risk-safety factor relationships are very sensitive to the hydrologic loading probability model used. The risk-safety factor relationships can be used to design new flood levee systems or analyze old systems; to determine risk factors; to evaluate expected damage; and to determine minimum costs, either construction or damage. (Cassar-FRC)
W82-01307

HYDROELECTRICAL MODEL FOR OPTIMAL OPERATION OF A SINGLE MULTIPURPOSE RESERVOIR,
National Water Plan Commission, Mexico City.
For primary bibliographic entry see Field 6A.
W82-01329

YANGTZE GORGES SCHEME COULD YIELD 110 TWH/YEAR.
International Water Power and Dam Construction, Vol 33, No 4, p 21-23, April, 1981.

Descriptors: *People's Republic of China, *Hydroelectric power, *Hydroelectric plants, Powerplants, Electric power production, *Yangtze River, Site selection, Flood control, Navigable rivers, Navigation, Planning, *Dam construction, Asia, China.

A massive hydroelectric plant is currently being planned for the Yangtze River in the People's Republic of China. The proposed 200-meter high prestressed concrete dam will include a hydroelectric power station, which will have a 25 GW capacity and will generate 110 TWh per year. Two sites for the dam are under consideration, both of which are located at the end of the Xiling Gorge on the Yangtze River. The Yangtze River, which is 6380 kilometers long, has an estimated total power potential of 230 GW, which is 2.5 times that of all the rivers in the United States. The Gezhouba dam, currently under consturction, is a first step towards building a power project on the river. Although the lake behind the Gezhouba dam will raise the water level of the Yangtze by more than 20 meters, the proposed project will still involve one of the biggest lock systems in the world. Located at the vital intersection of north and south and east and west, the proposed project will provide electricity for industries in many river ports, coastal cities, And mining areas. The lake behind the proposed project will also facilitate navigation of the three gorges upstream from the dam, which are currently hazardous, and eliminate the necessity to switch cargo to navigation channel. The new reservoir will also be able to control flooding in downstream areas. (Carroll-FRC)
W82-01394

HYDRAULIC MODEL STUDY OF DAULE-PERIPA SPILLWAY AND OUTLET WORKS,
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
K. L. Houston.
Report GR-81-9, June, 1981. 83 p, 61 Fig, 13 Tab.

Descriptors: *Hydraulic models, *Spillways, *Outlets, *Model studies, Erosion, Flow discharge, Hydroelectric plants, River beds, Stilling basins, Daule-Peripa spillway, Daule River, *Ecuador.

Two hydraulic models were built and studied to verify the original design of the Daule-Peripa spillway and outlet works to be constructed on the Daule River in Ecuador. The 1:80-scale spillway model included the approach channel, spillway, outlet works, powerplant, and downstream river channel. The model showed that excavation was not necessary in the spillway approach channel. A discharge curve and gate opening combinations were derived from the model. The flow over the crest was satisfactory with the piers shortened; however, it impinged upon the gate trunnion pins at higher discharges. On the spillway chute, all offsets greater than 3 mm should be ground to a 1:10 chamber. The stilling basin walls were overtopped for discharges greater than 2300 cu m/s; however, pressures indicated that they would remain stable. The velocities downstream of the stilling basin were within the design range; however, the riverbed eroded for about 24 m downstream of the apron. The 1:50.65-scale outlet works model included two 9-m-diameter concrete-lined tunnels with intakes for either diversion flow or for flow through the penstock and permanent outlet works. The model provided discharge information for the uncontrolled diversion flow and the gated permanent outlet works. Flow through the tunnel bends and velocities downstream of the stilling basins were satisfactory. No erosion occurred downstream of the outlet works or the powerplant. The penstock intake with the trashrack installed passed all discharges without vortices being formed.
W82-01446

PERFORMANCE EVALUATION OF A STOCHASTIC OPTIMIZATION MODEL FOR RESERVOIR DESIGN AND MANAGEMENT WITH EXPLICIT RELIABILITY CRITERIA,
Purdue Univ., Lafatette IN. School of Civil Engineering.
M. H. Houck, and B. Datta.
Water Resources Research, Vol 17, No 4, p 827-832, August, 1981. 4 Tab, 23 Ref.

Descriptors: *Reservoir design, *Reservoir operation, Reservoir releases, Reservoir capacity, Stochastic process, Linear programming, *Model studies, Mathematical models, Planning.

A multiple linear decision rule (LDR) model for reservoir design and operation proved superior to a single-LDR model in an application to a hypothetical reservoir on the Gunpowder River, Maryland. Under identical operating requirements the multiple LDR models designated smaller reservoir capacities and more closely simulated expected performance criteria than did single-LDR models. As the number of LDR's in a season (each conditioned on the previous season's streamflow) increased, the optimal capacity decreased. The multiple-LDR models require more data and manipulation of numbers and are slightly larger than single-LDR models, but remain within reasonable computability limits. (Cassar-FRC)
W82-01462

NORTHFIELD MOUNTAIN PUMPED STORAGE PROJECT: PERFORMANCE,
Stone and Webster Engineering Corp., Boston, MA.
W. F. Swiger, P. A. Wild, and T. J. Lamb.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No GT6, p 673-689, June, 1980. 9 Fig, 16 Ref.

Descriptors: *Dam construction, Dam stability, Performance evaluation, Dams, Dam design, *Design criteria, Civil engineering, Leakage, *Powerplants, Seepage, Cooling water, Water storage, Reservoirs, Surge tanks, Northfield Mountain Project, *Massachusetts.

The performance of civil works at the Northfield Mountain Pumped Storage Project has met design standards. Minimal leakage occurs from the upper reservoir, and the amount of seepage into the powerhouse and underground works is also small. The vertical ventilation shaft collects leakage from the pressure shaft occurring along a bedding plane shear. Part of this water is used in cooling equipment, while the remainder is discharged to the tailrace tunnel. During excavation, elastic movements of the roof and walls of the powerhouse cavern occurred. Since the excavation has been completed, no additional movements have been observed in 8 years. The dam of the upper reservoir has settled at a faster rate, probably due to the rapid cycling of water of a pumped storage facility. Tiltmeter studies during start-up and initial operation showed small elastic rock motions consistent with directions and character of load applications. No detailed analytical predictions of movement were made with which to compare measured values. (Geiger-FRC)
W82-01517

SITING AND DESIGN OF TAILINGS IMPOUNDMENTS,
Klohn Leonoff Inc., Denver, CO.
S. G. Vick.
Mining Engineering, Vol 33, No 6, p 653-657, June, 1981. 4 Fig.

Descriptors: *Tailings, *Wastewater treatment, *Dam design, Mine wastes, Waste disposal, Dam construction, Gravity dams, Separation techniques, Mine drainage, Dam sites, Metals, Underground waste disposal, Ocean dumping.

Some major factors to be considered in the design of tailings disposal facilities and some available methods for this purpose are discussed. The site characteristics which should be examined are topography, drainage area, geology/seismicity, precipitation and evaporation. The tailings' graduation, physical and chemical properties and clay content should be known for possible use as dam fill material. The pH, metallic cations and anions and othe toxic materials of the effluent must be characteristized along with its oxidation or leaching potential. Essential features of the mine or mill to be studied are the tailings and effluent output, recirculation capacity, and amount of sand tailings that may be used for backfilling. The advantages and disadvantages of three dam designs, the upstream, downstream and centerline methods, are presented. Other underground tailings disposal options include slope backfilling and 'below grade' disposal, which is required for the disposal of uranium tailings. The possibilities of thickened discharge methods and offshore disposal of tailings are also considered. (Geiger-FRC)
W82-01588

ROSARIO DOMINICANA'S CYANIDE TAILINGS DAM CONSTRUCTION AND OPERATION.
Martiki Coal Corp., Denver, CO.
For primary bibliographic entry see Field 5D.
W82-01589

8B. Hydraulics

EVALUATION OF EFFECTIVE BOUNDARY ROUGHNESS FOR GRAVEL-BED RIVERS,
New Brunswick Univ., Fredericton. Dept. of Civil Engineering.
D. I. Bray.
Canadian Journal of Civil Engineering, Vol 7, No 2, p 392-397, 1980. 4 Fig, 1 Tab, 7 Ref.

Descriptors: *Boundary process, *Gravel, *River beds, Rivers, River flow, *Flow velocity, Mathematical studies, Estimating equations, *Hydraulic roughness.

An optimum means for estimating the effective boundary roughness for the Keulegan equations was evaluated using data for 67 Alberta gravel-bed river reaches. The value of C (coefficient equal to effective boundary roughness over bed material size) decreased with an increase in the characteristic bed material size used to evaluate the effective boundary roughness. The characteristic bed material size must be multiplied by a constant when determining the effective boundary roughness. When using the Keulegan equation, errors in the estimation of the average velocity may range from 20 to 100% when the optimum measure of effective boundary layer is not used. For values of relative smoothness greater than 3.5, the Keulegan equation should be used. When relative smoothness is less than 3.5, the energy degradation results more from a jet than a wake process, and a jet process represents a different class of energy degradation than that assumed in the Keulegan method. (Small-FRC)
W82-01161

VERTICAL VELOCITY PROFILES IN STRATIFIED FLOWS,
Geological Survey, NSTL Station, MS. Gulf Coast Hydroscience Center.
S. C. McCutcheon.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol 107, No HY8, p 973-988, August, 1981. 6 Fig, 3 Tab, 21 Ref.

Descriptors: *Flow characteristics, *Velocity distribution, *Stratified flow, Flow velocity, Monin-Obukhov equation, Prandtl-von Karman equation, Boundary layers, Open-channel flow, Turbulent flow.

A study was conducted on the shape of the vertical velocity profile in a unidirectional, two-dimensional, turbulent, fully developed, continuously stratified flow. Turbulence was produced by movement of fluid over a rough boundary. Flows in laboratory flumes stratified by salt were used to verify the predicted results. The Prandtl-von Karman velocity law was not applicable to stratified flows, but the velocity profile expressions, modified with the Monin-Obukhov scaling length, described velocity gradients and vertical profiles in stably stratified flows. The coefficient for a linear approximation of the Monin-Obukhov function was 5.8 + or - 0.3, comparable to the accepted value of 5.2 + or - 0.5 for atmospheric boundary layer flows. The importance of the width to depth ratio in stratified flow, noted in previous studies, was confirmed. If the width to depth ratio is 4.3 or less, stratified flows in flumes are characterized by peculiar vertical velocity profiles. Previous work by French (1978) was declared non-valid for two-dimensional flows because the Monin-Obukhov scaling length was incorrectly defined. (Cassar-FRC)
W82-01171

OPTIMAL RISK-BASED DESIGN OF FLOOD LEVEE SYSTEMS,
Nevada Univ. System, Reno. Dept. of Civil Engineering.
Y. K. Tung, and L. W. Mays.
Water Resources Research, Vol 17, No 4, p 843-852, August, 1981. 8 Fig, 9 Tab, 6 Ref.

Descriptors: *Levees, *Risks, *Flood protection, Flood damage, Flood control, *Design criteria, Model studies, Hydraulic structures, Hydraulic engineering, Hydraulic models, Hydraulic design, Optimization.

Optimal design procedures for flood levee systems are determined using methods of risk analysis which include both hydraulic and hydrologic uncertainties. The objective is to find the best flood levee system design for the least total cost. Two models are developed for this purpose: dynamic programming (DP) and discrete differential dynamic programming (DDDP). The 3 design philosophies examined considered 3 degrees of risk; no risk, only inherent hydrologic risk, and both hydrologic and hydraulic risks. The DDDP approach produced more accurate results with much less computer time and storage than did DP in an example using data from the Guadalupe River, Texas. (Cassar-FRC)
W82-01313

DEVELOPMENT OF UPTON INTAKE WORKS, RIVER SEVERN SUPPLY SCHEME, WITH THE AID OF A MODEL,
Severn-Trent Water Authority, Birmingham (England).
M. S. Kothari.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 3, p 245-258, May, 1981. 5 Fig, 1 Tab, 4 Ref.

Descriptors: *Intakes, *Model testing, *Hydraulics, Water treatment facilities, Upton, *Severn River, Rivers, Sumps, Screens, Tunnels, *Great Britain.

A 1:5 scale model was used to determine the maximum reliable abstraction rate for the existing Upton intake for the River Severn. The model confirmed that the present abstraction rate of 182 million liters per day produces no evident surface or submerged vortices. Therefore, no baffles in sumps or increased submergence of pumps are necessary. To reduce energy losses at the connection between the main and interconnecting tunnels and to avoid a hydraulic jump, a smooth concrete connecting piece was installed. If an abstraction rate of 200 million liters per day (projected for 2001) or greater is required, an extra tunnel would be essential between the common bandscreen chamber and the new sump. The model predicts that replacement of two bandscreens (1200 mm) would allow an abstraction rate of 170 million liters per day, lower than the calculated 182 million liters per day. Replacement of all three bandscreens would allow a reliable abstraction rate of 200 million liters per day, according to both model and calculated results. (Cassar-FRC)
W82-01395

8C. Hydraulic Machinery

TRICKLE IRRIGATION LATERAL DESIGN ON SLOPING FIELDS,
Louisiana State Univ., Baton Rouge. Dept. of Agricultural Engineering.
H. J. Braud, and A. M. Soom.
Transactions of the ASAE, Vol 24, No 4, p 941-944, 950, July/August, 1981. 7 Fig, 1 Tab, 14 Ref.

Descriptors: *Trickle irrigation, *Slopes, Design criteria, Irrigation, Irrigation practices, Hydraulics, *Irrigation design.

New analytical expressions are presented to relate the physical variables in lateral line hydraulics. Design equations are offered in implicit form, relating the variables in trickle lateral hydraulics. They are: length, diameter, operating pressure, emitter flow characteristics, tube friction, discharge uniformity coefficient, emitter discharge exponent, emitter spacing requirement, and land slope. The equations are in such a form that they can be inserted into many programmable digital calculators and are very convenient for direct application to field use. The equations eliminate the need for design charts or tables. Both the Hazen-Williams and the Blasius fraction equations are used and compared through graphic solutions for limiting lateral length. (Baker-FRC)
W82-01537

SIGNIFICANT FEATURES OF EMITTER FLUSHING MODE CHARACTERISTICS,
Rain Bird Western Sales Corp., Glendora, CA.
For primary bibliographic entry see Field 3F.
W82-01576

8D. Soil Mechanics

LIQUEFACTION ANALYSIS FOR MULTIDIRECTIONAL SHAKING,
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
J. Ghaboussi, and S. U. Dikmen.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT5, p 605-627, May, 1981. 16 Fig, 16 Ref.

Descriptors: *Liquefaction, *Seismic waves, *Earthquakes, Waves, Soil mechanics, Model studies, Computers, Soil engineering, Soil water, Interstitial water, Stability analysis, Construction.

A new method of analysis is presented for computing the response and the liquefaction potential of horizontally-layered ground subjected to three components of earthquake base acceleration. The theoretical basis of the proposed method of analysis is described, and the main aspects of the response to multidirectional shaking are demonstrated through a series of case studies. These case studies were performed by using a new computer program, LASS-III, which was developed for analysis of multidirectional shaking of horizontally-layered ground. The results of the analyses indicate that the vertical component of base acceleration has only a minor influence on the development and pattern of liquefaction, that interaction between the two horizontal components of shaking significantly influences the development and pattern of liquefaction, that increasing the amplitude of the base acceleration in a one-directional analysis such that the peak base acceleration equals the resultant of the peak base accelerations in two directions does not completely reproduce the major effects present in a two-directional analysis, and that interaction between the two horizontal components of shaking produced surface response spectra which were somehow different from those of one-directional analysis. (Baker-FRC)
W82-01169

CYCLIC STRENGTHS COMPARED FOR TWO SAMPLING TECHNIQUES,
Ertec Western Inc., Long Beach, CA.
C. Espana, R. C. Chaney, and D. Duffy.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT5, p 563-576, May, 1981. 9 Fig, 2 Tab, 6 Ref.

Descriptors: *Sampling, *Liquefaction, Nuclear powerplants, Powerplants, Soil properties, Soil engineering, Soil water, Water pollution prevention, Construction, Soil strength, Soil tests.

Cyclic triaxial liquefaction test results have been compared for soil samples obtained by two different sampling and laboratory preparation techniques. Results indicate a reduced cyclic strength for samples that were obtained by Pitcher barrel sampling followed by tube cutting and trimming by mechanical extrusion into a mold. Significantly higher cyclic strengths were obtained for large-diameter, hand-carved, block samples which were further hand-trimmed into test-size specimens by either further hand-trimming, saturation and trimming, or freezing and trimming. The lower cyclic strengths noted for the tube samples were believed to be caused by the destruction of adhesion bonds that existed between soil particles in situ. Soil sampling by block-sampling techniques minimized the destruction of these bonds. The formation of the adhesion bonds in granular material can be caused by the consolidation of a sand material under high effective stresses for a short time, or under low effect stresses for a long time. The process of Pitcher barrel sampling and subsequent laboratory preparation combined to cause disturbance. Block sampling into clear large-diameter plastic cylinders allowed retention of a reasonably undisturbed sample. The laboratory preparation techniques where block samples were saturated, drained, and then further hand-carved, or frozen with liquid nitrogen and hand-carved, were effective in minimizing disturbance. (Baker-FRC)
W82-01170

SOIL-BENTONITE SUPPLY TRENCH CUTOFFS,
Engineered Construction International, Inc., Pittsburg, PA.
D. J. D'Appolonia.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No GT4, p 399-417, April, 1980. 15 Fig, 1 Tab.

Descriptors: *Slurries, *Cutoffs, *Bentonite, *Backfill, Trenches, Soil filters, Barriers, Viscosity, Permeability, Earthworks, Soil water, Soil compaction, *Seepage control, *Structural engineering.

Cutoff walls using the soil-bentonite backfill method of slurry trench construction are used for seepage control in excavating, water retaining structures, and preventing pollutant seepage from contaminating ground water. Many of the slurry trench cutoff walls in the United States were not designed to meet project specifications. Similar requirements are often assigned to totally different projects. Rational designing involves selecting engineering properties that meet specific properties of wall permeability, certain environmental criteria, and cutoff compressibility and strength. Specification provisions for slurry properties, trench

excavation, backfill placement, and backfill material for the project are recommended. The slurry should have a minimum viscosity of 40 sec-Marsh to assure trench stability and good filter cake formation. The unit weight of the slurry, as sampled near the bottom of the trench, should be at least 240 kilograms/cu meter lighter than the backfill for proper slurry displacement. The trench should have a minimum width of 610 mm. Trenches keyed in soil should have a minimum key depth of 0.6 m. The backfill material should have a uniform consistency corresponding to a slump of 50-150 mm at the time of placement. The backfill should be composed of granular material containing 20-40% fines to minimize permeability and compressibility. Plastic fines may be used to increase impermeability. Bentonite should be added to the mix and the water content of the soil should be controlled. When the contained fluid is a pollutant changes in permeability of the wall may be regulated by adjusting the content of the fines. (Geiger-FRC)
W82-01599

8F. Concrete

AN INVESTIGATION INTO THE EFFECTS OF THERMAL MOVEMENT IN THE WALLS OF SERVICE RESERVOIRS,
Severn-Trent Water Authority, Burmingham (England).
A. A. Redhead.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 3, p 203-214, May, 1981. 11 Fig, 6 Ref.

Descriptors: *Concrete construction, *Reservoir construction, *Cracks, *Ladbroke Service Reservoir, Thermal stress, *England.

The Ladbroke Service Reservoir, South Warwickshire, England, was constructed in two compartments of equal size using sulfate resisting Portland cement to reduce the effects of alkali attack, which had caused serious cracks in another reservoir built 14 years previously. This paper reports the results of an investigation of thermal cracks which occurred after the walls had been cast on site. Both single and fragmented cracks, usually vertical, developed 400 to 2400 mm from the base 4 or 5 days after pouring the concrete. Stress gages recorded movement as high as 1.66 mm per 10 C change on a cold morning. The single cracks that formed near the thickest part of the wall were closest to the area of greatest heat of hydration. The fragmented cracks were caused by one wall pulling on the adjacent wall. Cracks in this reservoir did not exceed those allowed in the design, and all midpanel hairline cracks healed 10 days after the reservoir was filled. Suggestions to reduce the tendency to cracking were: use steel shuttering, cool the hottest portion of the wall with cold water sprays, use low heat cement, and cast the wall stem no more than 4 or 5 days after the wall base has been poured. (Cassar-FRC)
W82-01396

8G. Materials

REDESIGN CONTROLS MANHOLE LEAKAGE,
W. L. Sheppard.
Water and Sewage Works, Vol 127, No 2, p 50-52, February, 1980. 1 Fig, 9 Ref.

Descriptors: *Sewers, *Construction methods, Construction materials, Construction joints, Sewer systems, *Waterproofing, Sealants, Manhole construction.

Weaknesses of the most common designs for manhole construction are described, including the sewer connections made from them, and the redesign necessary to correct the weaknesses. The manhole that is to be liquid tight must be structurally strong, incorporate a liquid-tight membrane, and be protected from physical or other damage by an internal brick or tile lining. A liquid-tight precast manhole requires continuous water stops inserted at all junctures of all sections and at the connection with the bottom slab, if this is separate. All joints should be tooled and filled with a strong, water-tight adhesive such as epoxy. A manhole may also be fashioned completely from fiberglass-reinforced plastic, somewhat like a cylindrical tank. The selection of membrane and mortar materials for use in industrial waste sewers must take into consideration the range of chemical content and temperature of wastes to be passing through. (Baker-FRC)
W82-01237

8I. Fisheries Engineering

EVIDENCE OF NATURAL REPRODUCTION BY PLANTED LAKE TROUT IN LAKE MICHIGAN,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
D. J. Jude, S. A. Klinger, and M. D. Enk.
Journal of Great Lakes Research, Vol 7, No 1, p 57-61, 1981. 1 Fig, 1 Tab, 33 Ref.

Descriptors: *Fish populations, Lakes, *Lake Michigan, Great Lakes, Fish, *Trout, Powerplants, Fish management, *Fish establishment, Fish eggs.

Sampling for lake trout fry was performed near the J. H. Campbell Power Plant, in southeastern Lake Michigan, near Port Sheldon, Michigan, where new offshore intake and discharge pipelines were built. About 1296 meters of pipeline were covered with 10- to 20- cm diameter crushed limestone, 594 meters of which was overlaid with an incomplete layer of 1.2 to 1.5 meter diameter, 900 kg limestone boulders. An additional length of 360 meters had a complete 1.5 meter layer of large riprap covering a base of crushed limestone. Rocky substrate was therefore available at all depth contours from shore to 11 meters. Since 1965 over 34 million finclipped lake trout yearlings have been stocked in Lake Michigan in an effort to reestablish self-sustaining populations. Lake trout fry were first collected on 21 April, 1980, by the larval fish sled in 12 and 15 meters of water in the area of new riprap at the north transect. During 19-22 May, 1980, lake trout fry were widely dispersed. Appearance of lake trout fry at the south transect, 3.1 km south of the area in which they are believed to have hatched, suggests either extensive movements by these fish or drifting with currents or both. Successful spawning near the Campbell Plant was probably related to the newly placed riprap. (Baker-FRC)
W82-01194

COOLING WATER INTAKE SCREENING DEVICES USED TO REDUCE ENTRAINMENT AND IMPINGEMENT,
National Power Plant Team, Ann Arbor, MI.
E. S. Fritz.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-116055, Price codes: A03 in paper copy, A01 in microfiche. Report FWS/OBS-76/20.9, July, 1980. 24 p, 12 Fig, 20 Ref.

Descriptors: *Entrainment, Impingement, *Intakes, *Screens, *Cooling water, Environmental effects, Mortality, Aquatic animals, Radial wells.

Closed cycle cooling systems reduce the volume of cooling water withdrawn from a water body at least 90% of that required for once-through cooling systems. To be considered an alternative to closed cycle cooling a once-through cooling system with its screening device must be shown to reduce impingement and entrainment mortality for aquatic organisms by 90% of that expected of a once-through system fitted with a vertical traveling screen. Cooling water intake screening devices evaluated include modified vertical traveling screens, single-entrance double-exit screens, horizontal traveling screens, passive intake screens, radial wells, artificial filter beds, and porous dikes. The intake technologies show some promise for reducing the impacts of entrainment and impingement. However, evidence is insufficient to demonstrate that any of these intake systems alone or in combination can afford the protection that is presently attainable by closed cycle cooling. The most effective systems, the radial well and artificial filter bed, can only provide enough water for make up water in closed cycle systems. The screening devices, both active and passive, do not yet have a sufficient data base to demonstrate effectiveness or reliability. More experience is needed operating and maintaining these devices before they can be considered as alternatives to closed cycle cooling for minimizing the adverse impact of cooling water intakes. (Moore-SRC)
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